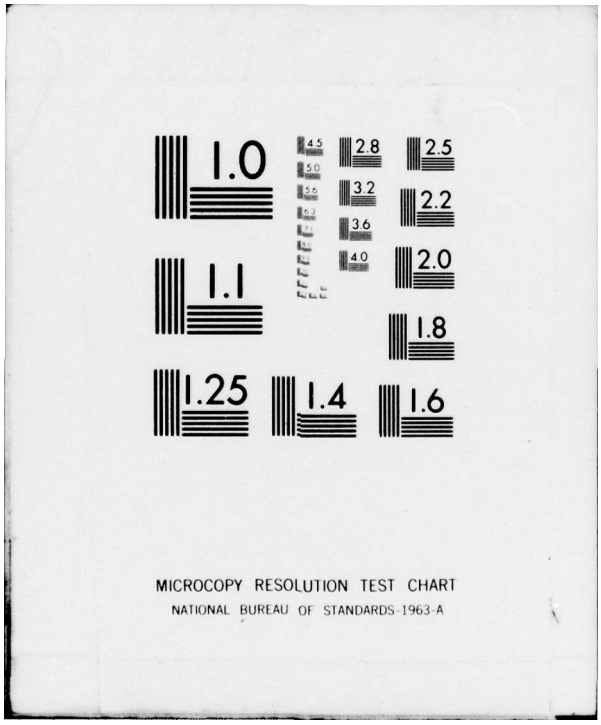
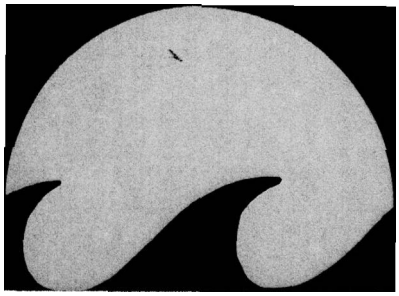
AD-A074 834 TETRA TECH INC ARLINGTON VA F/G 5/1
DEPARTMENT OF THE NAVY ENERGY PROGRAM AND PLAN - 1979.(U)
AUG 79 N00014-78-C-0097
UNCLASSIFIED TETRAT-TT-A-6065-79-405 OPNAV-41P4.A NL

1 OF 3
AD A074834

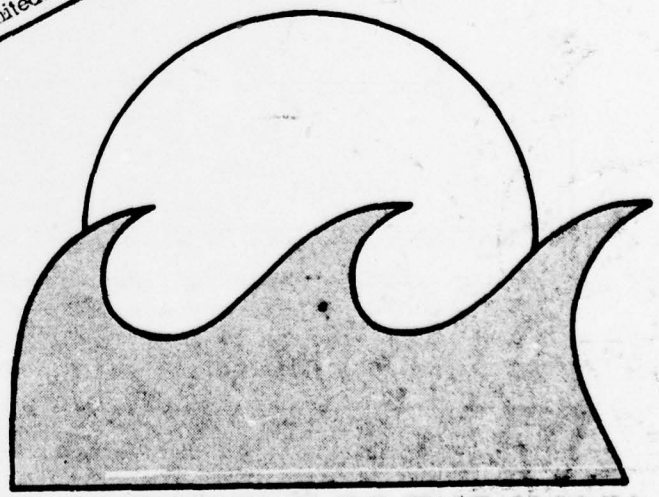

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A



(12)

ENERGY PROGRAM AND PLAN–1979

AUGUST 1979



DEPARTMENT OF THE NAVY

U.S. NAVY ENERGY OFFICE (OPNAV-413)
U.S. MARINE CORPS (CMC, LFF-2)

DOCUMENT OPNAV 41P4.A

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: OPNAV 41P4.A	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): Department of the Navy Energy Program and Plan - 1979	5. TYPE OF REPORT & PERIOD COVERED: Technical Report
	6. PERFORMING ORG. REPORT NUMBER: TT-A-6065-79-405
7. AUTHOR(s): Tetra Tech, Inc.	8. CONTRACT OR GRANT NUMBER(s): N00014-78-C-0097
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Tetra Tech, Inc., 1911 Fort Myer Drive, Arlington, Virginia 22209	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: Navy Energy Office, Office of the Chief of Naval Operations, Department of the Navy, Washington, D.C. 10350	12. REPORT DATE: August 1979 13. NUMBER OF PAGES: 332
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release, Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Energy, Energy Situation, Navy Energy Program Accomplishments, Navy Energy Management, Navy Energy Awareness Activities, Navy Energy Management Training, Navy Energy Information Systems, Navy Energy Distribution and Allocation, Navy Energy Conservation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Department of the Navy Energy Program and Plan - 1979 provides an annual report on the status and direction of energy resource management and planning. The document includes an annual report on Navy Department energy activities and accomplishments and an overview of the energy situation including naval energy requirements and cost projections to the year 2000. The energy program is described in terms of Navy Department energy goals, energy management and organization, fuel distribution and allocation, and shore, ship, and aircraft operations. The latter includes energy conservation, use of synthetic fuels, and alternative energy sources.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

388 103

DEPARTMENT OF THE NAVY
OFFICE OF THE SECRETARY
WASHINGTON, D. C. 20350

14 September 1979

From: Secretary of the Navy
To: Distribution List

Subj: Department of the Navy Energy Program and Plan - 1979

Ref: (a) U.S. Navy Energy Plan and Program - 1978, OPNAV 41P4

Encl: (1) OPNAV 41P4.A, Department of the Navy Energy Program and Plan - 1979

1. Reference (a) was issued in response to a growing national energy crisis. Since the issuance of reference (a), the national energy situation has continued to worsen. Our nation and the Department of the Navy continue to be highly dependent upon dwindling foreign sources of petroleum, and petroleum prices continue to escalate rapidly. The need for an aggressive, well-organized energy program and plan is even more important now than ever before.

2. The Navy Energy Plan and Program - 1979, forwarded as enclosure (1), provides you with the most up-to-date programs, goals, operations standards and funding status to assist you in evaluating and implementing an effective energy program. In addition, a summary of program accomplishments for FY 78 is provided to advise you of successfully implemented programs. In this regard, the Navy and Marine Corps community can take pride in the energy program progress made through FY 78.

3. The Department of the Navy has reduced energy consumption 28% since the 1973 oil embargo. Further evidence of the Navy's vigorous energy effort was apparent during observance of the first annual Navy Department Energy Awareness Week and in the enthusiastic competition during the first Secretary of the Navy Energy Conservation Awards. Notwithstanding the Department of the Navy's achievements, a great deal remains to be accomplished. Accordingly, your continued efforts and leadership are urgently required to ensure that we can continue to meet our national commitments.

James Woolsey

R. James Woolsey
Acting Secretary of the Navy

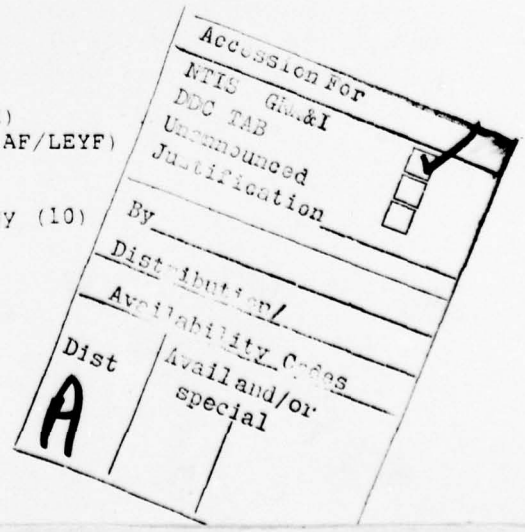
Distribution:
SNDL
A1 (Immediate Office of the Secretary)
A2A (Chief of Information) (only)

Distribution list: (cont.)

A4A (Chief of Naval Material)
A6 (Headquarters U.S. Marine Corps) (Code LFF)
B3 (College and University) (less ICAF)
B3 (Industrial College of the Armed Forces) (only) (3)
B5 (U.S. Coast Guard Headquarters) (only)
21A (Fleet Commanders in Chief)
22A (Fleet Commanders)
23 (Force Commanders)
24 (Type Commanders) (less 24J)
26KK2 (Petroleum Training Unit PAC)
45B (4th Marine Division) (only)
46A (Fleet Marine Force Commands)
46B (4th Marine Aircraft Wing) (only)
C4L (Director of Navy Laboratories)
E3A (Laboratory ONR)
E6D (Office of Information)
E7A (Audit Service Director)
FA23 (Naval Facility LANT)
FB29 (Supply Depot PAC)
FB36 (Naval Facility PAC)
FE2 (Security Station)
FF38 (U.S. Naval Academy)
FKA1 (Systems Command Headquarters)
FKN1 (Facilities Engineering Command Division)
FKN5 (Public Works Center NAVFACENGCOM)
FKM (NAVSUP Shore Activities) (less FKM1)
FKP3 (Sea Systems Command Representatives)
FKP7 (Shipyards)
FKR1B (Air Rework Facility) (2 each)
FKR7E (Aviation Logistics Center)
FR1 (Chief of Naval Reserves)
FT63 (Chief of Naval Education and Training Support)
FT64 (Training Equipment Center)
FT73 (Naval Postgraduate School)
V2 (Barracks Supporting)
V3 (MARCOR Air Bases Commanders)
V5 (MARCOR Air Stations)
V8 (Recruit Depots)
V12 (Development and Education Command)
V14 (Headquarters Battalion)
V15 (Marine Corps District) (1st only)
V16 (Base)
V21 (Marine Corps Finance Center)
V23 (Logistics Base)

CNO OPs: 00, 09, 090, 90, 92, 098, 008, 02, 03, 04, 05, 06

Copy to:
CHNAVMAT (MAT-08T3) (10)
COMNAVFACENGCOM (FAC-102) (25)
ASD(MRA&L)DE (2)
JCS(J-4)
Army Energy Office (HQ DA-DALO-TSE) (2)
Air Force Energy Management Division (AF/LEYF)
Defense Logistics Agency
Defense Fuel Supply Center
ASN(R,E&S) Special Assistant for Energy (10)



IN MEMORIAM

Dr. Peter Waterman, 1918–1979, was Special Assistant for Energy in the Office of the Assistant Secretary of the Navy for Research, Engineering, and Systems, 1975–1978. A dedicated professional, Dr. Waterman distinguished himself repeatedly during his 35 years of service to the United States Navy. Having already established himself as an authority in fire control and weaponry for ships and aircraft at the Naval Research Laboratory where he started his career in 1943, his superlative performance caused him to be designated Special Assistant to the Assistant Secretary of the Navy for Research and Development in August 1968. He served in this post until 1975, with a temporary break from February to September 1973 when he served as Acting Assistant Secretary.

Immediately following the energy crisis in 1973, Dr. Waterman seized the initiative and started a series of actions that quickly put the Navy in the forefront in establishing energy conservation, awareness, and technology programs. His personal zeal and acute awareness of the need for high-level attention to energy matters within the Department of the Navy were recognized in 1975, when he was designated as the Special Assistant for Energy and Related Matters, reporting to the Under Secretary of the Navy and the Assistant Secretary of the Navy for Research, Engineering, and Systems.

Dr. Waterman was the prime mover in creating the Navy Energy and Natural Resources R&D Office, Office of the Chief of Naval Material, and later, the Navy Energy Office, Office of the Chief of Naval Operations. He took a strong personal interest in all aspects of energy conservation and the use of alternative energy sources, including the use of synthetic fuels as substitutes for dwindling supplies of petroleum-based fuels. Prior to his retirement in 1978, he served as the Department of Defense member on the Presidential Solar Applications Committee.

His outstanding accomplishments have been recognized by the honors and awards bestowed upon him during his long and productive career. For excellence in the fields of fire control and servomechanisms, he was awarded the Navy Meritorious Civilian Service Award in 1945; in 1957, and again in 1961, he received the Navy Distinguished Civilian Service Award for excellence in the fields of airborne weapons and control systems, and Fleet ballistic missile systems, respectively. In 1966, the Department of Defense presented the Distinguished Civilian Service Award to him for his contributions to the Navy's offensive and defensive capabilities. During the period 1973–1978, he received three additional distinguished civilian service awards from the Secretary of the Navy for his services in the Office of the Assistant Secretary of the Navy for Research, Engineering, and Systems.

During his lifetime, coal, petroleum products, and nuclear fission were the primary sources of energy, providing power to propel naval ships, aircraft, and vehicles, and for use in buildings and industrial facilities ashore. He was, however, also able to witness and be a part of the early stages of development of many new energy sources, i.e., oil shale, tar sands, coal gasification and liquefaction, fuel cells, geothermal, hydrogen, solar, wind, biomass, ocean, and magnetohydrodynamics. He was exceedingly conscious of the threat of diminishing energy resources and became a leader in making not only the Navy, but the Department of Defense, the Congress, and the Executive Office of the President aware of the need for action.

The achievements of Dr. Peter Waterman in advancing this nation's energy programs were indeed remarkable, and it is fitting that this *Energy Program and Plan—1979* honor those achievements.

PREFACE

The U.S. Department of the Navy *Energy Program and Plan—1979* provides an annual report on the status and direction of energy resource management and planning within the Navy Department. The document includes an annual report on Navy Department energy activities, and an overview of the energy situation including naval energy requirements and cost projections to the year 2000.

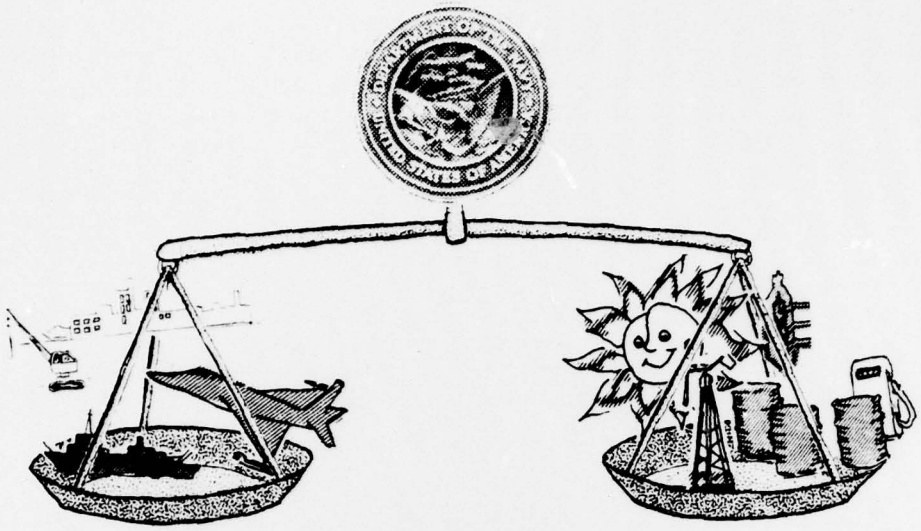
The energy program is described in terms of Navy Department energy goals, energy management and organization, fuel distribution and allocation, and shore, ship, and aircraft operations. The latter includes energy conservation, use of synthetic fuels, and alternative energy sources. An FY 1978 accomplishments section provides an overview of significant achievements for facilities, ship and aircraft operations, and research and development.

The energy plan consists of project descriptions, milestones, resources appropriated for FY 1979, and the Executive Budget submitted to Congress for FY 1980 through FY 1984. Additional resources required to meet the approved Navy Department goals, as outlined by the Navy Energy Office and the Marine Corps in the POM-81 submission, are also stated.

CONTENTS

CONTENTS (CONT'D)

CONTENTS (CONT'D)



EXECUTIVE SUMMARY

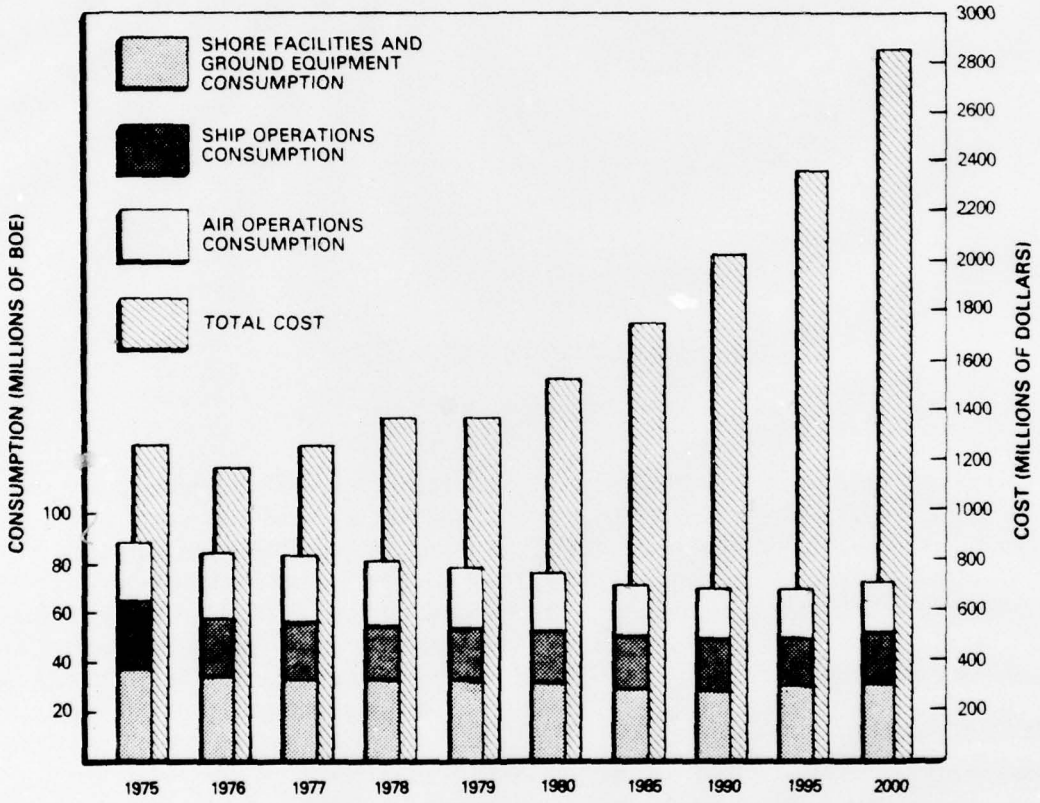
The Department of the Navy *Energy Program and Plan—1979* provides the Secretary of the Navy, Chief of Naval Operations, and Commandant of the Marine Corps staffs, and commanders at all echelons with a better understanding of the impact of rapidly escalating fuel costs and the measures being taken to control and reduce energy consumption. The plan includes a brief assessment of the world and national energy situation as it affects naval shore facilities, ship, and aircraft operations. Historical energy usage within the Department of the Navy since FY 1975 and projected energy requirements and costs to the year 2000 are included. Navy energy program FY 1978 accomplishments are summarized, the Department of the Navy energy management organization is outlined, and each of the major energy programs are described. The energy plan section consists of ongoing and planned energy projects which are being implemented in FY 1979 through FY 1985.

THE ENERGY SITUATION

In FY 1978, the Navy consumed about 80.6 million barrels of oil equivalent (BOE) at a cost of about $1.4 billion—28.9 percent for ship operations, 28.8 percent for aircraft operations, and 42.3 percent for shore activities including vehicles and ground support equipment. Of this, about 72 percent was in the form of liquid fuels derived from petroleum.

The Navy Department's future (to 2000) energy requirements are based on the need to

obtain liquid petroleum fuels in sufficient quantities to operate conventional power plants and engines for ships and aircraft now in the fleet or in production. Projected Navy energy needs and costs from FY 1975 to 2000 are shown below. While energy consumption should decline from 89.1 million BOE in FY 1975 to 71.6 million BOE in 2000, energy costs are expected to increase from $1.24 billion in FY 1975 to $2.83 billion in 2000 (in FY 1978 dollars).



Satisfying Navy mission requirements for liquid hydrocarbon fuels is becoming increasingly costly as U.S. petroleum reserves dwindle. Further, continued heavy dependence on imported petroleum is risky, given the need to maintain national security and defense. Therefore, Navy Department energy resource management planning must include the need to supplement liquid fuels derived from natural petroleum crude with fuels refined from syn-

thetic crude processed from oil shale, tar sands, or coal. Petroleum shortages will occur by the mid-1980s when world demand for petroleum is expected to exceed production, and the situation will become even more critical as world petroleum production peaks in the early 1990s. World competition for these dwindling supplies will tend to drive the price upward. It is projected that synthetic fuels will become economically competitive during this period of shortage and increased cost for petroleum. With this situation in mind, and recognizing the long lead times involved, the Navy Department is supporting not only energy conservation efforts, but also efforts aimed at developing a capability to use synthetic fuels and alternative energy sources, such as coal, solar, wind, geothermal, refuse-derived fuels, and biomass.

NAVY ENERGY PROGRAM FY 1978 ACCOMPLISHMENTS

During FY 1978, the Department of the Navy made significant progress in its energy program and reduced energy usage 8.5 million BOE as compared to the FY 1975 year. This energy reduction is equivalent to a cost reduction of $145.3 million in 1978 dollars. Ship steaming hours in FY 1978 totaled 18.6 percent lower and aircraft flying hours 10.3 percent lower than in FY 1975, resulting in energy usage reductions of 5.3 million BOE and 0.4 million BOE, respectively. Energy conservation and resource management efforts accounted for 29.4 percent of the total reduction, resulting in 2.8 million BOE savings.

During FY 1978, the Navy Department continued to refine its energy conservation goals and improve its energy resource management activities. The results of this effort included publication of the U.S. Navy *Energy Plan and Program—1978* in June 1978 by the Navy Energy Office (OP-413). The document consists of an overview of energy conservation programs and a detailed plan for those energy projects to be completed for FY 1978 through FY 1985. In the 1978 Navy *Energy Plan and Program,* the Navy also established revised energy goals and provided an annual report to the Secretary of the Navy (SECNAV) and the Office of the Secretary of Defense.

The Navy Energy and Natural Resources R&D Office (MAT-08T3) published its annual U.S. Navy *Energy R&D Program Plan* in October 1978. This plan identifies and assesses promising technological solutions to the Navy's operational energy problems. It includes a description of ongoing and planned projects and resource requirements for FY 1979 through FY 1984.

The Navy established an annual energy conservation awards program as a means of recognizing those Navy and Marine Corps activities that are outstanding in energy conservation and resource management. Awards were presented in 1978 in each of seven categories:

- Large ships—awarded to USS John F. Kennedy (CV 67).
- Small ships (crew less than 400)—awarded to USS Blakely (FF 1072).
- Aviation squadrons—awarded to Air Test and Evaluation Squadron, VX-1, Patuxent River, Maryland.
- Large Navy shore activities—awarded to PMTC, Point Mugu, California.

- Small Navy shore activities (resident and nonresident base population under 500)—awarded to NAVSECGRUACT, Winter Harbor, Maine.
- Marine Corps activities—awarded to MCAS, Iwakuni, Japan.
- Naval industrial facilities—awarded to Pearl Harbor Naval Shipyard, Pearl Harbor, Hawaii.

Winners of the FY 1978 awards were announced in June 1979, and include:

- Small ships—awarded to USS Arthur W. Radford (DD 968).
- Aviation squadrons—awarded to Fleet Composite Squadron Seven, VC-7, Alameda, California.
- Large Navy shore facilities—awarded to Naval Air Test Center, Patuxent River, Maryland.
- Small Navy shore facilities—awarded to Navy Regional Medical Center, Corpus Christi, Texas.
- Marine Corps activities—awarded to MCAS, Beaufort, South Carolina.
- Naval industrial facilities—awarded to Navy Public Works Center, Norfolk, Virginia.

The first annual Navy Department Energy Awareness Week was observed 23-27 October 1978. The initial energy awareness week observances were highly successful in increasing the level of understanding of the present and future energy situation faced by the Navy. The activities provided an excellent means for publicizing Navy energy goals and for demonstrating many unique energy conservation and energy substitution programs.

During FY 1978, the shore energy conservation program resulted in energy savings of 1.2 million BOE at an estimated cost savings of $20.5 million (1978 dollars), as compared to the FY 1975 baseline year. These savings resulted largely from increased energy awareness, improved energy resource management, the Energy Conservation Investment Program (ECIP), and use of more energy efficient vehicles.

ECIP funding in FY 1978 was $26.1 million, and investment in the program since its inception in FY 1976 now totals $107.4 million. Annual energy cost savings now exceed $15 million and by 1985 should reach over $60 million. Completed projects include improvements to heating, ventilating, and air conditioning; energy monitoring and control; and electrical and lighting systems. Building alterations, such as the installation of air curtains and reduction of glass area, also have resulted in cost savings.

The Navy is pursuing an intensive shipboard energy conservation R&D program in an effort to achieve an overall savings of 20 percent per steaming hour in FY 1985, based on average performance by ship class. The Navy has placed considerable emphasis on hull maintenance to include underwater hull and propeller cleaning, ultrasonic biofouling prevention, and use of organometallic polymer hull coatings.

The Navy also achieved significant savings in aircraft operations during FY 1978 through use of flight simulators and computer assisted flight planning. To identify and

classify the principal fuel users, the Navy conducted fuel use surveys of 36 different types of Navy and Marine Corps aircraft.

From January 1977 through September 1978, a total of 88,225 barrels of crude shale oil was produced under Navy and DOE contracts. In late October 1978, the shale crude was delivered to the Standard Oil of Ohio (SOHIO) refinery at Toledo, Ohio, where, under Navy contract, the crude was refined into military specification fuels for testing by the military services and other agencies. Basically, the refining process consisted of first stage hydrotreating/hydrocracking followed by fractional distillation to various fuel products. Final nitrogen removal was accomplished by acid treating and clay filtration. The final jet (JP-5, JP-8) and shipboard (DFM) fuels produced by SOHIO meet all of the current military fuel specifications. These fuels are being shipped to various laboratories for further testing.

DEPARTMENT OF THE NAVY ENERGY MANAGEMENT ORGANIZATION

The Deputy Chief of Naval Operations for Logistics (OP-04) is primarily responsible for Navy Department energy resource management, and provides policy coordination and guidance related to energy matters. The Director of the Material Division (OP-41) provides the principal staff support for energy matters and chairs the Chief of Naval Operations (CNO) Energy Action Group.

The Navy Energy Office (OP-413) is responsible to OP-41 for planning and monitoring efficient use of energy throughout the Navy. The Navy Energy Office also provides policy guidance on all matters pertaining to energy and energy conservation, except those relating to nuclear energy; ensures that the Navy can provide the required energy resources to the operating forces and shore establishments; coordinates with the Office of the CNO and acts as a central point of contact for Navy energy and energy conservation matters (other than nuclear energy); and participates in functions of interdepartmental interest pertaining to energy matters.

The Deputy Chief of Naval Material for Logistics (MAT-04) is the senior staff officer of the Naval Material Command (NAVMAT), reporting to the CNO on all matters associated with energy management. His responsibilities encompass implementing policy and directing the overall energy management program within NAVMAT and for coordinating the program specifically assigned to other Chief of Naval Material offices and activities. In the exercise of this responsibility, the Assistant Deputy Chief of Naval Material for Facilities, Environment, Energy and Industrial Resources (MAT-044) acts as the coordinator for the program.

The Director of the Navy Energy and Natural Resources R&D Office (MAT-08T3) supervises the planning, execution, and appraisal of NAVMAT's energy and natural resources exploratory, advanced, and engineering development programs. To fulfill its responsibilities, the Navy Energy and Natural Resources R&D Office staff must review all Navy programs involving energy technology evolution or applications to assess the feasi-

bility of achieving program goals, the validity of the technical approach, the adequacy of management and funding to accomplish these goals, the feasibility of proposed schedules, and the progress and future prospects of the programs.

The Marine Corps Deputy Chief of Staff for Installations and Logistics (DC/S for I&L) is responsible for implementing the Marine Corps energy conservation program. In this regard, the DC/S for I&L establishes criteria, develops program elements, monitors achievements, and takes corrective action as required to achieve desired results regarding utilities energy and vehicle fuels conservation.

DEPARTMENT OF THE NAVY ENERGY PROGRAM

To maintain a well balanced energy program which is responsive to federal and defense energy policy guidelines the Navy Department has established energy goals. The Navy will measure accomplishment of these goals at the activity level except where noted. The goals apply to savings realized by the end of 1985 as compared to the FY 1975 baseline year.

- Reduction of 20 percent in existing facilities per gross square foot of building floor area.
- Reduction of 45 percent in new facilities per gross square foot of building floor area, to be achieved through new construction design specifications.
- Savings of 15 percent in fuel consumption by ground support equipment.
- Reduction of 20 percent in fossil fuel consumption per ship underway steaming hour.
- Reduction of 90 percent in fleet and shore fuel surveys (measured at the overall Navy level).
- Reduction of 5 percent in fuel consumption per flight hour.
- Savings of 9 percent in fuel consumption through simulator substitution.
- Substitution of coal, solid waste, refuse-derived fuels, and biomass for 10 percent of the 1985 installation energy used ashore (measured at the overall Navy Department level).
- Substitution of solar and geothermal energy for 1 percent of the 1985 installation energy used ashore (measured at the overall Navy Department level).

The Navy Department energy program includes strategies for energy resource management, energy distribution and allocation, energy utilization and conservation, use of synthetic fuels, and development of alternative energy sources. These strategies provide a balanced approach for achieving the Navy's energy objectives and goals in the shore, ship, and aircraft operational areas.

The energy resource management strategy includes developing a comprehensive energy program and plan and provides for continual review of actions taken throughout the Navy Department to minimize the adverse effect of energy-related problems. Programs include energy management, awareness, training, and information systems.

The energy distribution and allocation strategy supports a worldwide fuel and materials logistics system that can efficiently furnish the necessary energy supplies in the form and quantity required to ensure that there will be no mission degradation caused by domestic or worldwide energy shortages. Programs include petroleum, oil and lubricants training, fuel management systems, Prepositioned War Reserve Material Requirements, and contingency planning.

The energy conservation strategy is directed at eliminating wasteful energy use, developing and implementing more efficient power and propulsion equipment, and improving basic energy systems so that they will use less fuel.

The synthetic fuels effort is aimed at conducting laboratory test and evaluation projects to become an informed customer and develop a capability to utilize the products of the emerging synthetic fuels industry as soon as these products are commercially available.

The alternative energy sources strategy is aimed at utilizing renewable or more abundant energy resources. These energy sources include solar, wind, geothermal, refuse-derived fuels, and coal. The objective of this strategy is to test, evaluate, and implement alternative and advanced energy systems to reduce the use of petroleum-derived fuels.

Energy research and development (R&D) is also an essential part of the overall Navy energy program. The energy R&D program is structured to achieve specific goals in the three strategies related to energy conservation, synthetic fuels, and alternative energy sources.

DEPARTMENT OF THE NAVY ENERGY PLAN FOR FY 1979 THROUGH FY 1985

The Navy Department energy plan is the principal energy management and planning document used by the Navy Energy Office (OPNAV-413). It also serves as a means to inform the Secretary of the Navy and other interested Navy Department offices of program objectives, project descriptions, major milestones, and resource requirements.

Individual descriptions for each project within the energy program functional areas and strategies include a project description, milestones, Five-Year Development Plan (FYDP) and required funding levels, responsible activities, and estimated energy savings at both the FYDP and required funding levels. The FYDP funding level program reflects the approved FY 1980 budget submission. The FYDP represents an allocation of resources within Navy priorities. The required funding level is the Navy Department's estimate for future years. As new technology evolves and additional surveys are conducted, the plan will be modified to achieve the best allocation of resources to meet Navy objectives.

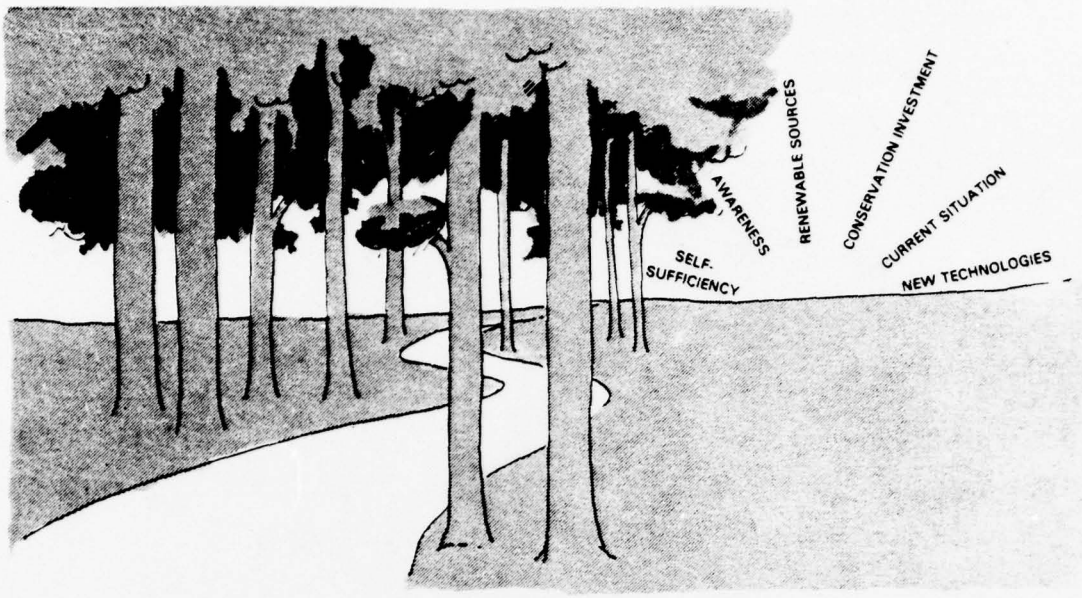
The total Navy energy program funding requirements (in millions of dollars) at both the FYDP and required funding levels for FY 1981 through FY 1985 are:

	FYDP	Required
Shore operations		
Energy conservation investment program	$278	$278
Energy engineering program	49	308
New buildings program	—	103
Other	28	196
Total shore	355	885
Ship operations		
Improved hull maintenance	34	56
Stack gas analyzer/combustion optimization	—	17
Total ship	34	73
Research and development	342	342
Total	$731	$1,300
Additional separate Marine Corps funding	$ 9	—

(Aircraft energy conservation, which includes improved engine efficiency and aircraft modifications, and testing of synthetic fuels for use in aircraft, is included in the RDT&E program. Development of aircraft simulators and computerized flight planning are funded outside of the energy program.)

The proposed FYDP funding level of $731 million, plus projects funded by the Department of Energy and other approved funding, should achieve annual energy savings of 52.38 trillion Btu beginning in FY 1985 at an estimated cost savings of $360 million in FY 1985 dollars. Substitution for 11.34 trillion Btu of petroleum at an estimated value of $78 million will also be realized with this funding level. At the required funding level of $1,300 million (plus other approved projects), annual energy savings of 73.95 trillion Btu are expected beginning in FY 1985 at an estimated cost savings of $510 million in FY 1985 dollars. Substitution for 23.91 trillion Btu of petroleum having an estimated value of $165 million in FY 1985 dollars also is expected at this level.

Separate Marine Corps funding of $9 million should achieve minimum annual energy savings of 0.14 trillion Btu beginning in FY 1985 at an estimated cost savings of $1.1 million in FY 1985 dollars.



INTRODUCTION

The Department of the Navy *Energy Program and Plan—1979* is based on an understanding of the need for aggressive, well-organized energy conservation and alternative energy source development programs within the Navy. While many of the complex issues involved—including energy availability and cost in the world market—cannot be precisely forecast, the need for immediate action is apparent.

The Department of the Navy initiated its energy-related activities in 1973, before the world oil embargo imposed by the Organization of Petroleum Exporting Countries. Since that time, the Navy has developed an energy resource management organization, established energy policy guidelines and goals, developed energy programs in all areas of naval operations, and has been in the forefront of Department of Defense (DOD) actions to mitigate the effects of rapidly increasing energy costs and rapidly declining resources.

DOD is the largest single U.S. energy consumer and accounts for 1.9 percent of the national energy consumption through direct usage; the energy consumption level for both DOD and related industries amounts to 5 percent of overall national energy use. DOD energy consumption in relation to U.S. total and federal government consumption is shown in Figure 1. The budgetary impact of increased energy costs already has caused DOD to operate nearer to the readiness margin than might otherwise have been countenanced. Therefore, it is essential that all elements of DOD use available energy resources in the most efficient manner possible.

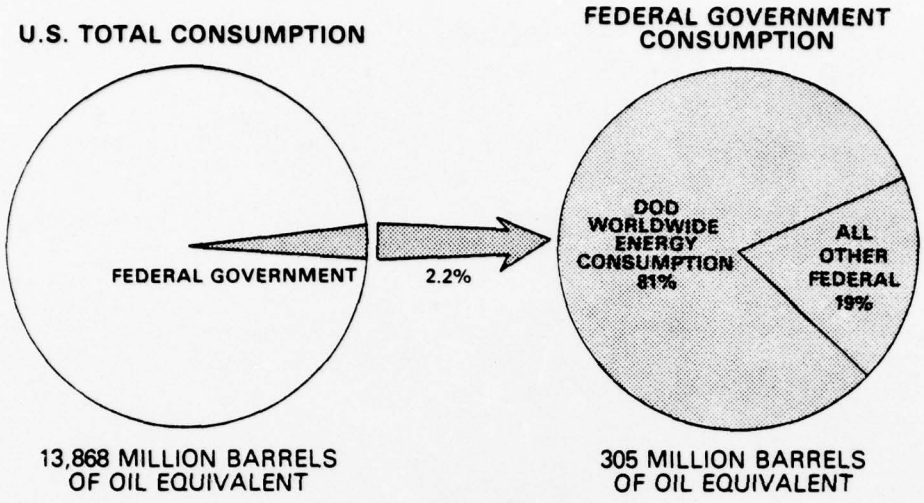


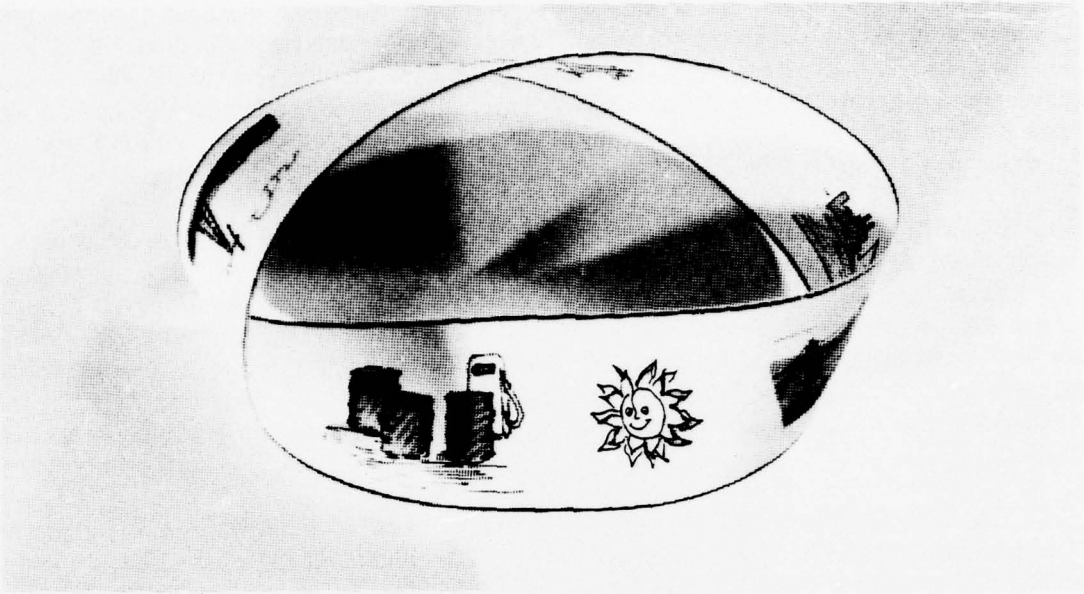
Figure 1. ENERGY CONSUMPTION—FY 1978

DOD energy management priorities reflect defense goals and objectives that cover energy availability, energy technology leading to conversion, and energy conservation, and are divided into four categories, or areas of action:

- Define management actions needed to assure fuel availability in periods of energy shortage and for military contingencies.
- Develop an energy research and development plan for mobility fuels.
- Implement DOD/Department of Energy initiatives in solar, photovoltaics, geothermal electric and space heating, wood fueled central power plants, coal gasification, fluidized-bed coal combustion, and energy technology showcases.
- Emphasize energy conservation.

Longer term DOD energy goals cover operational energy usage in installations, training, and tactical and strategic forces.

National security objectives can be achieved only if the United States is thoroughly prepared to meet essential industrial and military energy requirements. Attaining these objectives—deterring armed conflict, producing modern weapon systems, and maintaining the readiness of U.S. military forces—depends on all forms of available energy, particularly liquid fuels, to support worldwide commitments on the seas, in the air, and on the ground. In view of both the long lead times required to develop alternative energy sources and the rapidity with which currently used energy sources are being exhausted, the transition must begin immediately.



THE ENERGY SITUATION

An understanding of the Department of the Navy's projected energy situation requires a knowledge of the world and national energy situation. Limited energy resources must be conserved and substitute fuels developed. Extremely long lead times are involved and difficult decisions and commitments to effective energy resource management must be made now at all levels.

WORLD AND NATIONAL ENERGY SITUATION

In the last three decades, petroleum has been the major energy source for most of the industrialized nations, accounting for 44 percent of total world energy consumption. As a result, current energy problems for the industrialized nations are basically petroleum problems. These problems stem from the fact that the principal oil consumers are not the major oil producers and that world oil supplies are dwindling. The Third World nations are the predominant oil producers, with the Middle East and Africa presently producing 46 percent. The Communist countries account for 21 percent of total world oil production. However, the highly industrialized nations—the major consumers —account for 75 percent of total world oil consumption and only 22 percent of total world oil production.

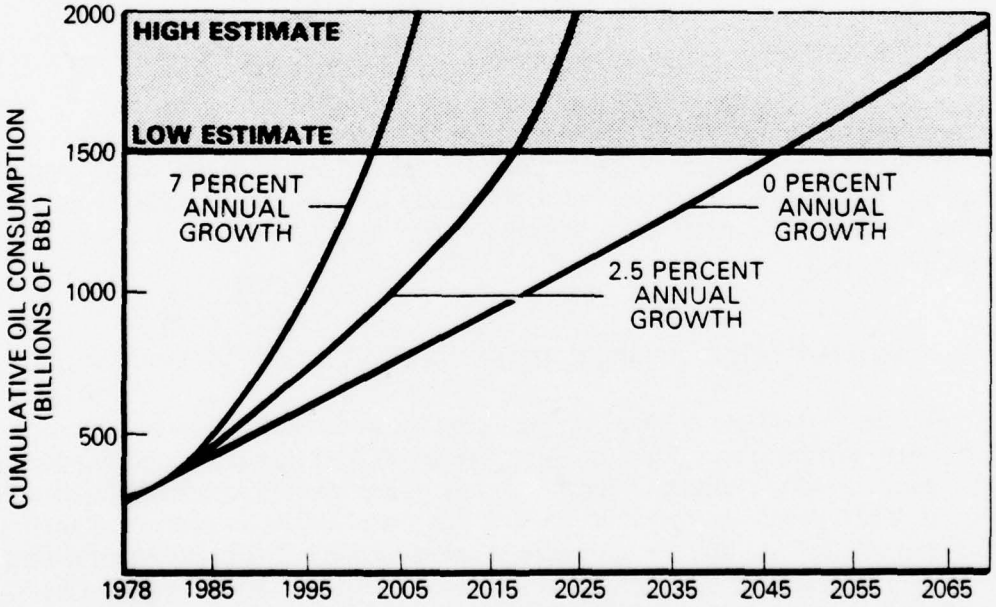
The imbalance between the world's major oil consumers and producers is likely to continue, given the geological distribution of proved crude oil reserves. The world's proved oil

reserves total an estimated 932 billion barrels. Over 46 percent of the proved crude reserves are located in Africa and the Middle East, 32 percent in Mexico (with the discovery of new resources in 1978), 10 percent in the Communist countries, and 5 percent in the Third World countries. Less than 7 percent of the total reserves is located in the United States, Canada, and Western Europe. Proved oil reserves in the United States totaled 29.5 billion barrels as of 1 January 1978. Of this, approximately 10 billion barrels are located in Alaska.

By 1985, world demand for oil is expected to exceed supply, and estimates indicate that world crude oil production will probably peak about 1990. Even now, increases in production exceed the rate of discovery of new petroleum reserves. If consumption levels grow at the historical rate of 7 percent per year, world resources of economically recoverable petroleum will be exhausted between 2003 and 2007, as shown in Figure 2. A conservative growth rate of 2.5 percent would delay exhaustion until between 2017 and 2025. In the unrealistic case of no change in consumption rate, exhaustion would occur no later than 2070.

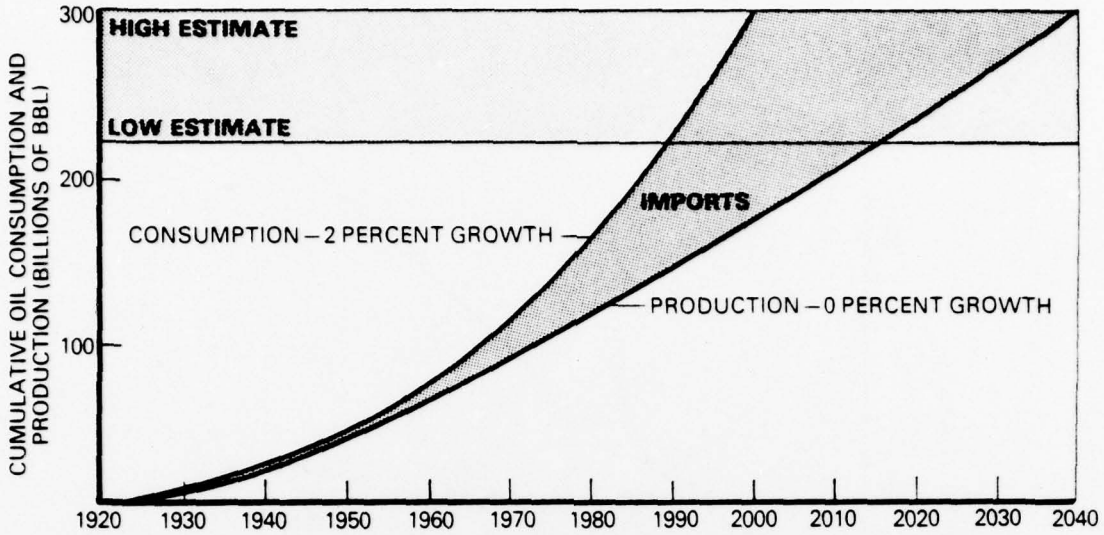
The U.S. Geological Survey (USGS) estimates, with 90 percent certainty, that the United States initially had oil resources of between 220 billion and 300 billion barrels. On the basis of projected no-growth production rates, U.S. current domestic petroleum resources could be exhausted between 2012 and 2039, as indicated in Figure 3.

Domestic oil production has declined from its peak levels in 1970 through 1972,



Sources: John D. Moody and Robert Geiger, "Petroleum Resources: How Much and Where?" *Technology Review,* March-April 1975; Organization for Economic Cooperation and Development, "Energy Prospects to 1985," 1975; Congressional Research Service, "Project Interdependence: U.S. and World Energy Outlook Through 1990," No. 95-31, June 1977; and National Academy of Sciences, "Mineral Resources and the Environment," February 1975.

Figure 2. PROJECTED WORLD EXHAUSTION DATES OF ULTIMATELY RECOVERABLE PETROLEUM RESOURCES



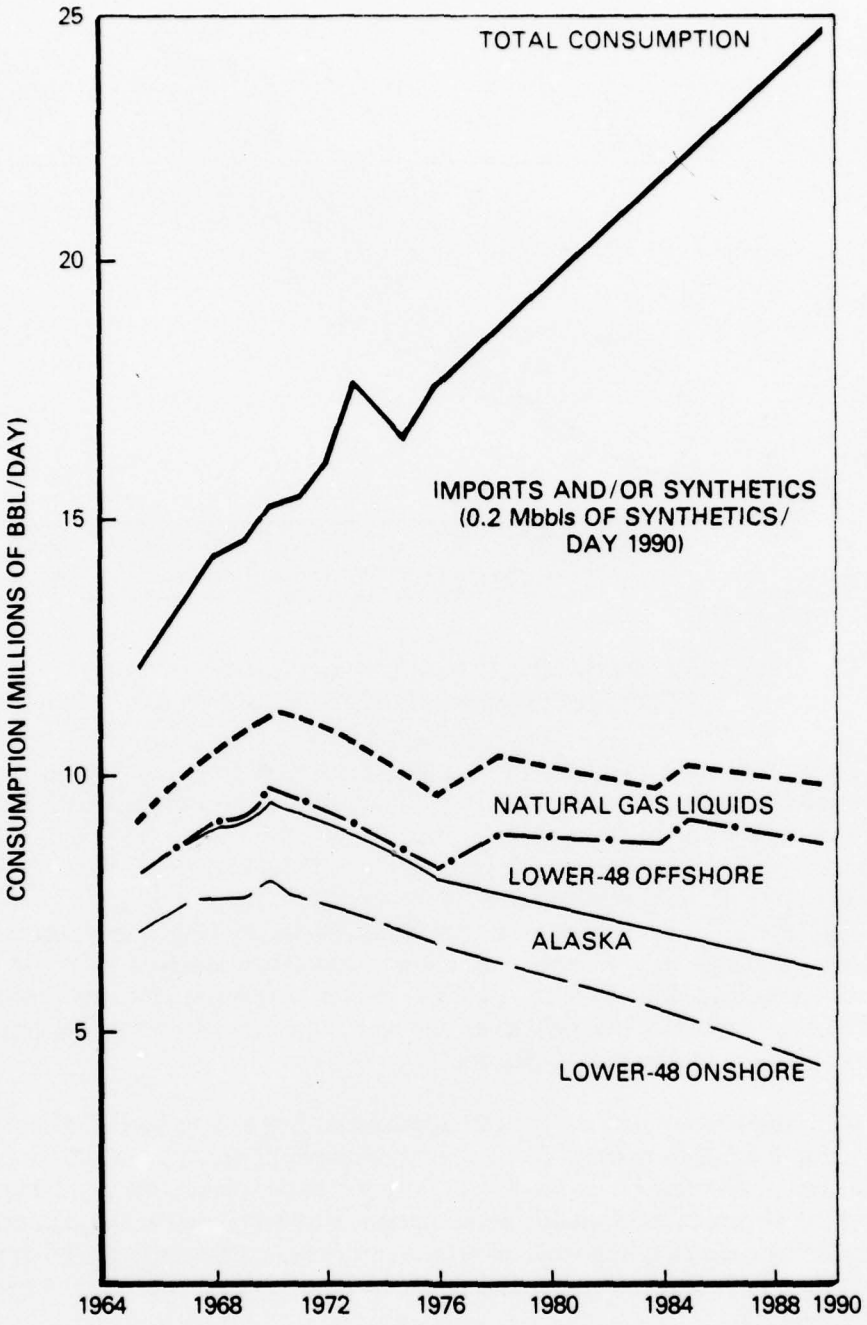
Sources: U.S. Geological Survey, "Geological Estimates of Undiscovered Recoverable Oil and Gas Resources in the United States," Circular 725, 1975; and DeGolyer and MacNaughton, "Twentieth Century Petroleum Statistics" (Dallas, TX: 1978).

Figure 3. PROJECTED U.S. EXHAUSTION DATES OF ULTIMATELY RECOVERABLE PETROLEUM RESOURCES

however, recent drilling activity and the first deliveries of oil from the Alaskan North Slope have arrested the decline for the near-term. Figure 4 illustrates projected U.S. petroleum liquids consumption. Aside from production in Alaska, domestic production is expected to continue to decline by about 9 percent from 1977 to 1985. At the same time, long-standing reliance on traditional oil producing areas in the contiguous United States is forecast to shift to "frontier" areas. These frontier areas include the Pacific and Atlantic offshore regions as well as Alaska. These new sources may allow crude oil production to be sustained, or possibly to increase, at least to 1985. By 1985, refined petroleum products consumption is expected to be 18 percent above 1977 levels and by 1990, further consumption growth is projected to extend the increase to 32 percent.

In 1978, the United States produced approximately 3 billion barrels of crude oil and consumed about 6 billion barrels. To fill the gap between production and consumption, the nation has been importing oil. In 1978, U.S. imports of petroleum and petroleum products accounted for 48 percent of domestic consumption. However, even at the high prices set by the oil exporting countries, imported oil presently is cheaper than synthetic oil derived from domestic sources of energy. Imports also delay the long-term exhaustion of America's own critical oil reserves.

To reduce the import vulnerability and forestall the impact of an oil embargo, the United States is stockpiling an emergency supply of crude oil along the Gulf coast in four salt domes and mines chosen as storage sites for the first phase of the Strategic Petroleum Reserve program. The United States began transporting crude oil to these sites in the summer of 1977. The long-range plan calls for 500 million to 1,000 million barrels of imported crude to be stored by the end of 1980.



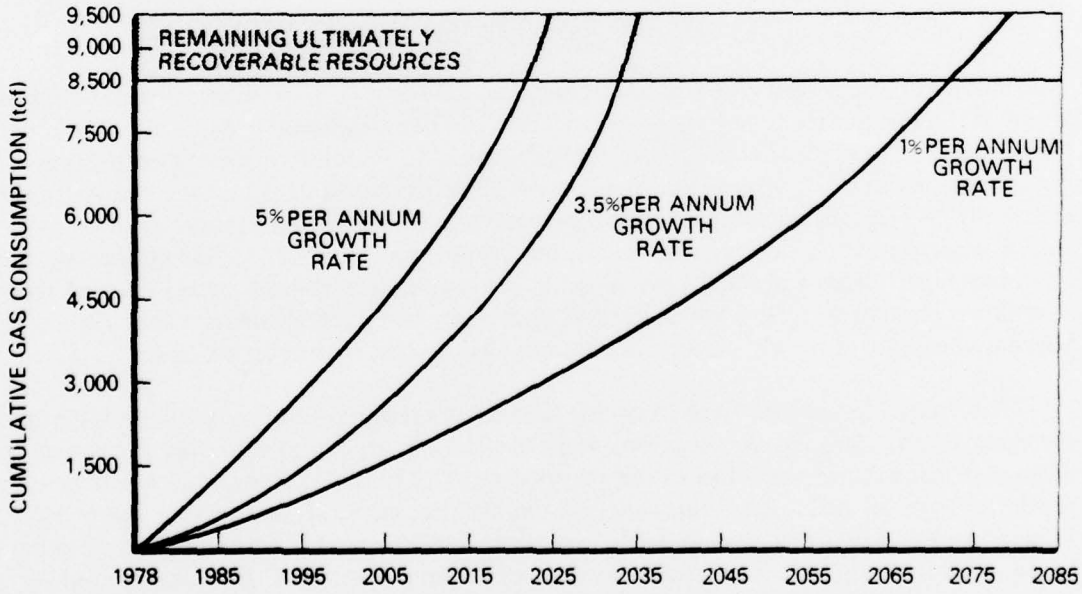
Source: U.S. Department of Energy, Energy Information Administration, 1978.

Figure 4. PROJECTED U.S. PETROLEUM LIQUIDS CONSUMPTION AND SOURCE OF SUPPLY

Natural gas, also, is a large energy source of the industrialized nations, currently supplying 18 percent of the world's energy needs. The United States and USSR are the predominant producers and consumers of natural gas, accounting for 60 percent of total world production and 67 percent of total world consumption. Of an initial world production resource base of about 10,000 trillion cubic feet (tcf) of natural gas, about 8,500 tcf are remaining, ultimately recoverable resources. Of this, 2,520 tcf are proved reserves: 37 percent is located in the Middle East and Africa; 38 percent in the USSR and other Communist countries; 16 percent in the United States, Canada, and Western Europe; and 9 percent in the Third World countries.

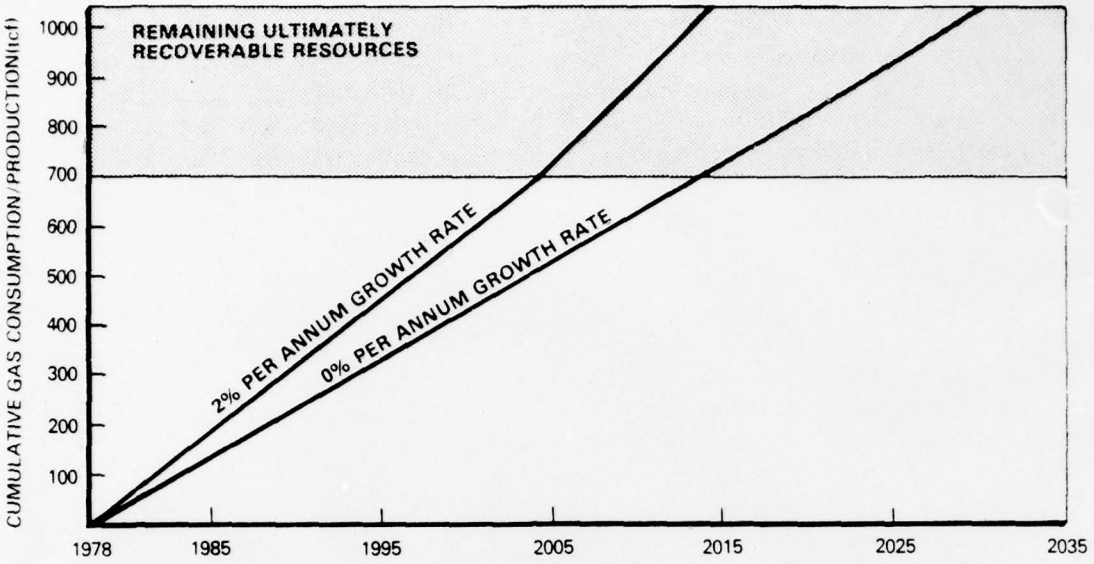
Using simplified assumptions about consumption and production policies, world natural gas exhaustion dates have been calculated. As shown in Figure 5, the world supply of natural gas could be depleted by 2022 if consumption grows at a rate of 5 percent. If the annual consumption rate were to grow only 1 percent, exhaustion would occur by 2072. Figure 6 shows projected U.S. natural gas exhaustion dates.

The nation's dependence on liquid petroleum and natural gas fuels is expected to continue. Conservation and storage measures will help prolong exhaustion dates, but strategies must also be developed, including the increased use of nuclear and hydropower for electricity production; further development and use of geothermal, solar, wind, and ocean resources; and production of synthetic fuels from such sources as oil shale, coal, tar sands,



Sources: Congressional Research Service, "Project Interdependence: U.S. and World Energy Outlook Through 1990," June 1977; *International Petroleum Encyclopedia, 1978* (Tulsa, OK: Petroleum Publishing Company, 1978); American Gas Association, "AGA Study Assesses World National Gas Supply," *The Oil and Gas Journal*, 13 February 1978; and American Gas Association, "A Comparison of U.S. and World Remaining Gas and Oil Resources," *Energy Analysis*, 19 January 1979.

Figure 5. WORLD NATURAL GAS EXHAUSTION

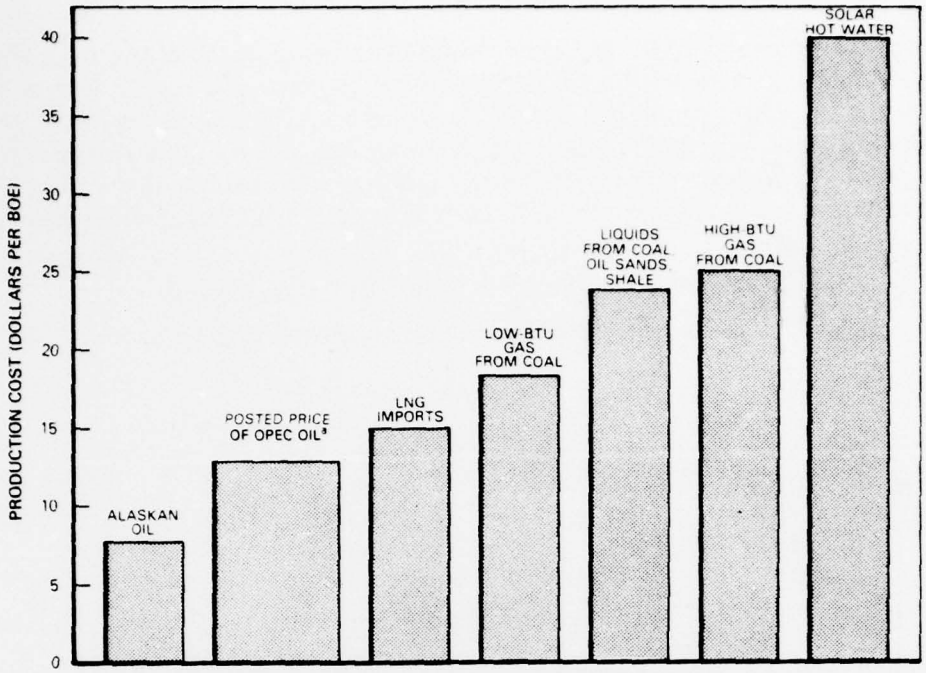


Note: Excludes imports, alternative production policies, and future discoveries.
Source: U.S. Geological Survey, "Geological Estimates of Undiscovered Recoverable Oil and Gas Resources in the United States," Circular 725, 1975.

Figure 6. PROJECTED U.S. EXHAUSTION OF REMAINING ULTIMATELY RECOVERABLE NATURAL GAS RESOURCES

and biomass. For example, the USGS estimated in 1975 that U.S. oil shale resources contain about 2 trillion barrels of oil equivalent (BOE); of this, 418 billion BOE are considered recoverable using current technology. In 1966, the USGS indicated known high-grade oil shale resources as 600 billion BOE. In either estimate, the resource is massive relative to the remaining 29.5 billion barrel U.S. petroleum reserves. However, the economics of commercial oil shale operations are uncertain; cost estimates range from $15 to $30 per barrel, and no commercial plants have operated. Production and distribution of energy derived from alternative sources of liquid hydrocarbons is capital- and energy-intensive (see Figure 7); alternative source costs are expected to increase as the cost of petroleum rises.

The United States will have to decide between increasing oil-import vulnerability and changing energy consumption patterns while developing energy alternatives to the use of petroleum and natural gas. Most of the energy consumed between now and 1990 will be supplied from the oil wells, gas fields, and coal mines that currently are serving the country. Experience has shown that considerable lead time (8 to 13 years) is required to develop new energy sources from concept to field use, and while development of these energy sources is progressing, they involve technological and economic uncertainties as well as environmental problems. In addition, several of these technologies can be applied only in particular geographic areas, further limiting their potential to ease the burden now carried by petroleum and natural gas. Until these technologies are further developed, then—through the 1980s, at least—primary reliance for energy will be on the conventional sources currently utilized.



[a]By June 1979 the price of OPEC oil varied from $14.55 to $18.00 per barrel.

Source: Business Week, 12 March 1979.

Figure 7. COST OF ALTERNATIVES TO IMPORTED OIL

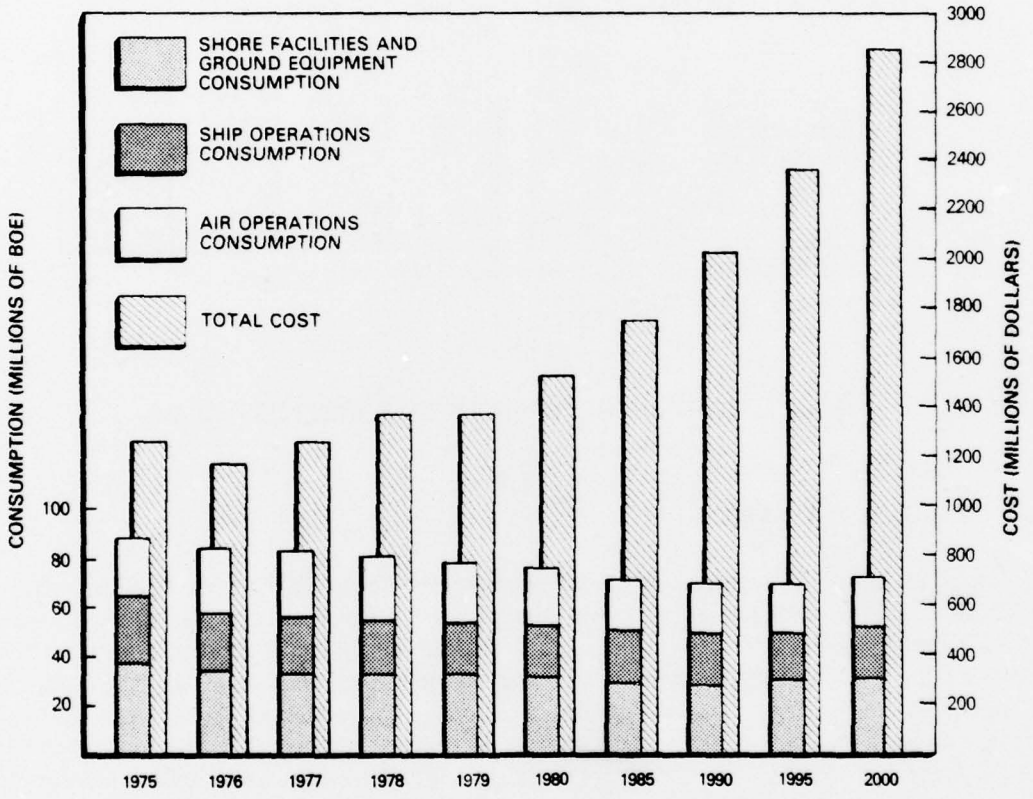
NAVY ENERGY SITUATION

In FY 1978, the Department of the Navy consumed about 80.6 million BOE at a cost of about $1.4 billion—28.9 percent for ship operations, 28.8 percent for aircraft operations, and 42.3 percent for shore activities including vehicles and ground support equipment. As do other sectors of the U.S. economy, the Department of Defense (DOD) and the Navy rely on conventional energy sources—primarily liquid hydrocarbon fuels derived from petroleum. Such petroleum products comprise 69 percent of the energy required by DOD and 72 percent of the Navy's energy requirements. Furthermore, DOD and the Navy will continue to depend on liquid hydrocarbon fuels into the next century because of their need for mobile systems and because current ships and aircraft, which require such fuels, will remain in the inventory for many years.

Satisfying Navy mission requirements for liquid hydrocarbon fuels is becoming increasingly costly as U.S. petroleum reserves dwindle. Further, continued heavy dependence on imported petroleum is risky, given the need to maintain national security and defense. Therefore, the Navy is preparing itself now for the time when world demand for petroleum exceeds supply. The Navy is adapting applicable energy technologies and technical procedures to reduce fuel consumption while maintaining the required readiness and operational effectiveness.

The projected energy needs and costs of the Department of the Navy, from FY 1975 through FY 2000, are shown in Figure 8. Navy energy requirements by fuel type or energy source for FY 1978 through FY 2000 are shown in Table 1. This energy profile is based on projected force levels, operations tempo, unit consumption, and the estimated savings from the Navy energy conservation program. The projections were made using the Navy Energy Usage Profile and Analysis System (NEUPAS). The basic data and assumptions used in this analysis are:

- January 1979 Five-Year Development Plan (FYDP) force levels.
- No major changes in operating tempos or deployment/exercise modes.



Activity	Millions of BOE									
	FY 1975	FY 1976	FY 1977	FY 1978	FY 1979	FY 1980	FY 1985	FY 1990	FY 1995	FY 2000
Air	24.9	24.7	24.1	23.2	23.1	23.0	23.0	23.3	22.7	21.8
Ship	28.9	23.7	23.6	23.3	23.0	22.6	19.5	19.8	19.0	19.3
Shore[a]	32.6	31.6	31.7	31.6	31.0	30.7	26.9	26.1	26.4	27.4
Ground support	2.7	2.7	2.5	2.5	2.5	2.4	2.2	2.2	2.2	2.2
Total	89.1	82.7	81.9	80.6	79.6	78.7	71.6	71.4	70.3	70.7

[a]Includes cold iron support.

Figure 8. NAVY ENERGY REQUIREMENTS BY ACTIVITY—FY 1975 TO FY 2000

Table 1. NAVY BEST ASSESSMENT OF ENERGY REQUIREMENTS FY 1978 THROUGH FY 2000 (Millions of BOE)

Energy Source	FY 1978	FY 1979	FY 1980	FY 1985	FY 1990	FY 1995	FY 2000
Petroleum							
AVGAS	0.5	0.5	0.5	0.5	0.4	0.4	0.3
MOGAS	1.0	1.0	1.0	1.0	1.0	1.0	1.0
JP-4	5.7	5.0	4.8	3.7	2.6	1.4	1.0
JP-5	17.6	18.5	19.0	19.7	21.1	21.0	20.8
DFM	18.6	19.2	19.7	18.1	18.9	18.8	19.0
NDF	3.4	3.0	2.0	1.0	1.0	1.0	1.0
NSFO/residual	1.1	0.6	0.5	0.5	0.3	0.3	0.2
Shore heating oil	9.4	9.8	9.7	5.1	2.3	2.2	2.2
Undefined	1.1	0.8	0.5	0.2	–	–	–
Total petroleum	58.4	58.4	57.7	49.8	47.6	46.1	45.5
Other							
Electricity	17.2	16.4	16.3	13.5	11.3	10.7	10.3
Natural gas	4.4	3.7	3.3	2.2	1.8	1.6	1.4
Coal	0.2	0.9	1.1	4.4	8.4	9.4	10.8
Propane/steam/hot water	0.4	0.2	0.3	0.3	0.3	0.3	0.3
Renewable	–	–	–	1.4	2.0	2.2	2.4
Total other	22.2	21.2	21.0	21.8	23.8	24.2	25.2
Total	80.6	79.6	78.7	71.6	71.4	70.3	70.7

- All Navy energy goals will be met.
- Navy energy cost data for FY 1978, Energy Information Administration data for 1985 and 1990, and Navy Energy Office estimates for 1995 and 2000.

The Navy expects its energy costs to increase from $1.37 billion in FY 1978 to $2.8 billion in FY 2000 (1978 dollars) (see Table 2). This increase is based on the Department of Energy's (DOE) Mid-Term Energy Forecasting System (MEFS) preliminary results of energy price surveys in March 1979 (see Table 3).

The Department of the Navy energy resource management goals support the federal energy program and related DOD energy programs. The purposes of these programs are to ensure that energy shortages do not interfere with DOD's capability to defend the nation and accomplish its national security mission, assist U.S. allies in overcoming their energy-related defense problems, and prevent energy-related coercion of the United States or its allies.

Defense energy objectives and goals include:

- Develop, with DOE, a national strategy to minimize disruption of liquid hydrocarbon fuel supply to DOD.
- Conduct R&D on propulsion systems to broaden the range of fuels DOD can use.
- Develop adequate specifications and testing methods for a broader range of military fuels.
- Plan for the contingency of a future transition from petroleum to synthetic fuels.

Table 2. NAVY BEST ESTIMATE OF ENERGY COSTS FY 1978 THROUGH FY 2000 (Millions of 1978 Dollars)

Energy Source	FY 1978	FY 1979	FY 1980	FY 1985	FY 1990	FY 1995	FY 2000
Petroleum							
AVGAS	12.1	12.4	13.6	21.9	19.9	22.6	19.3
MOGAS	22.1	21.3	24.0	43.8	49.8	56.6	64.3
JP-4	100.4	91.7	97.4	124.3	99.3	60.8	49.4
JP-5	324.7	354.3	402.6	691.7	842.1	952.8	1,072.7
DFM	344.3	362.1	434.2	481.8	552.5	709.9	926.8
NDF	63.7	56.6	44.1	26.6	29.2	37.8	48.8
NSFO/residual	20.0	10.2	8.5	11.3	7.5	9.8	8.5
Shore heating oil	138.7	148.7	165.4	115.4	57.5	71.8	93.8
Undefined	19.5	15.1	11.0	5.3	–	–	–
Total petroleum	1,045.5	1,072.4	1,200.8	1,522.1	1,657.8	1,922.1	2,283.6
Other							
Electricity	268.6	257.0	259.0	230.5	204.2	225.3	252.8
Natural gas	50.2	43.0	41.4	40.5	41.7	45.7	49.3
Coal	2.5	10.4	11.5	48.8	97.9	147.2	227.1
Propane/steam/hot water	10.5	5.6	8.6	9.2	10.1	13.7	18.5
Renewable (solar/geothermal)	–	–	–	a	a	a	a
Total other	331.8	316.0	320.5	329.0	353.9	431.9	547.7
Total	1,377.3	1,388.4	1,521.3	1,851.1	2,011.7	2,354.0	2,831.3

[a]Operating and maintenance costs for solar and geothermal systems cannot be estimated at this time.

Table 3. PROJECTED ENERGY PRICES FY 1978 THROUGH FY 2000 (1978 Dollars Per Barrel or BOE)[a]

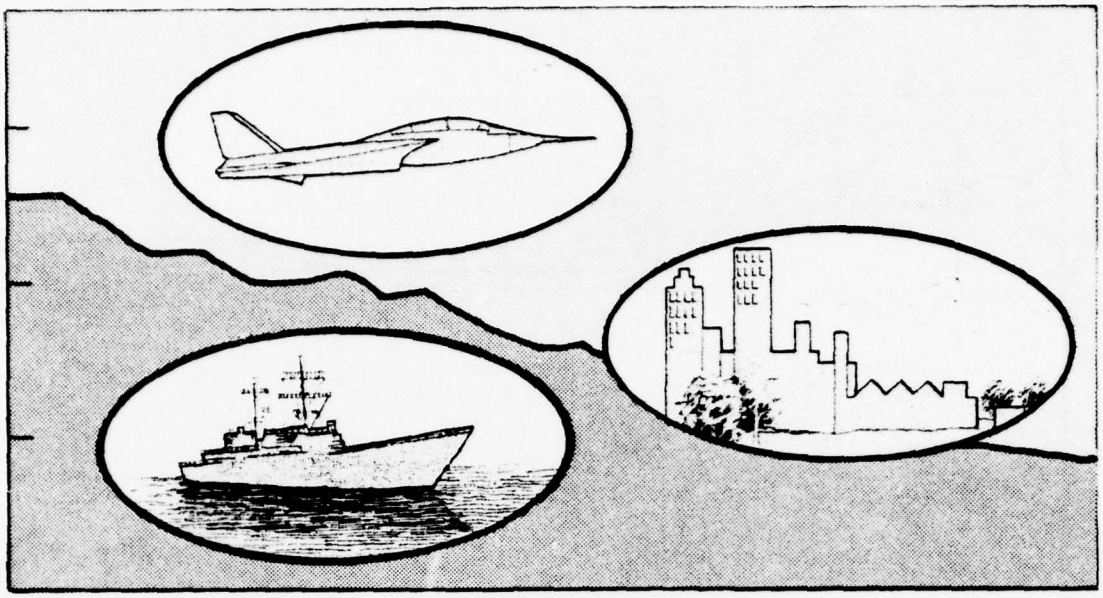
Energy Source	FY 1978	FY 1979	FY 1980	FY 1985	FY 1990	FY 1995	FY 2000
Petroleum							
AVGAS	23.39	24.78	27.24	43.77	49.76	56.57	64.31
MOGAS	22.81	21.29	24.01	43.77	49.76	56.57	64.31
JP-4	17.64	18.35	20.30	33.60	38.20	43.43	49.37
JP-5	18.52	19.15	21.19	35.11	39.91	45.37	51.57
DFM	18.52	18.86	22.04	26.62	29.23	37.76	48.78
NDF	18.52	18.86	22.04	26.62	29.23	37.76	48.78
NSFO/residual	17.39	17.01	17.05	22.62	25.00	32.65	42.64
Shore heating oil	14.83	15.17	17.05	22.62	25.00	32.65	42.64
Undefined	18.52	18.86	22.04	26.62	29.23	37.76	48.78
Other							
Electricity							
Generated	15.65	15.67	15.89	17.07	18.07	21.06	24.54
Delivered	53.40	53.48	54.24	58.23	61.65	71.86	83.76
Natural gas	11.34	11.61	12.54	18.39	23.14	28.54	35.20
Coal	10.15	10.28	10.41	11.08	11.66	15.66	21.03
Propane	27.70	28.10	28.50	30.51	33.58	45.53	61.73

[a]BOE = 5.8 million Btu

Sources: FY 1978—actual; FY 1979-80—OP-413; FY 1980-1995—Department of Energy, Energy Information Administration Mid-Term Energy Forecasting System (MEFS), Projection Series B (high case), formerly Project Interdependence Evaluation System (PIES) Model, March 1979.

- Adjust the logistics structure to handle any emergency situations necessary.
- Increase efficiency of mobile equipment use in operations and training.
- Increase use of simulators in training.
- Obtain 10 percent of installation energy in 1985 from more abundant and renewable solid fuels.
- Obtain 1 percent of installation energy in 1985 from solar and geothermal energy.
- Equip all natural gas-only heating plants over 5 million Btu per hour with an alternative fuel capability not later than 1982.
- Have a 30-day fuel oil supply on hand for all heating units greater than 5 million Btu per hour.
- Reduce energy consumption in existing buildings through the energy conservation investment program, energy conservation and management program, energy engineering program, and other management initiatives.
- Comply with energy conservation mandates of Executive Order and public law.
- Promote energy awareness.

The present trend of heavy reliance on imported petroleum will undoubtedly continue. At the present import level, ample fuel stocks will be available to the Navy through 1985, assuming no supply interruptions. Beyond 1985, when world demand will exceed supply, the Navy may face spot shortages of Military Specification (MILSPEC) fuels that will affect its operational capability. Accordingly, the Navy program is designed to initiate actions now to maintain the required readiness while using less fuel, operating more efficiently, using renewable or alternative energy sources, and being prepared to operate with synthetic petroleum fuels and/or less restrictive MILSPEC fuels. The following sections describe the Navy's FY 1978 accomplishments, energy goals and objectives, and its energy program and plan designed to accomplish these actions.



NAVY ENERGY PROGRAM FY 1978 ACCOMPLISHMENTS

During FY 1978, the Department of the Navy made significant progress in its energy program and reduced energy usage 8.5 million barrels of oil equivalent (BOE) as compared to the FY 1975 baseline year. This energy reduction is equivalent to a cost reduction of $145.3 million in 1978 dollars (see Figures 9 and 10). Ship steaming hours in FY 1978 totaled 18.6 percent lower and aircraft flying hours 10.3 percent lower than in FY 1975, resulting in energy usage reductions of 5.3 million BOE and 0.4 million BOE, respectively. Energy conservation and resource management efforts accounted for 29.4 percent of the total reduction, resulting in 2.8 million BOE savings. (A detailed analysis of historical energy usage is provided in Appendix A.) This section summarizes FY 1978 energy program accomplishments and indicates savings realized in Navy energy resource management; energy conservation awareness; shore, ship, and aircraft operations; and synthetic fuels programs.

ENERGY RESOURCE MANAGEMENT

During FY 1978, the Navy Department continued to refine its energy conservation goals and improve its energy resource management activities. The results of this effort included publication of the U.S. Navy *Energy Plan and Program—1978* (OPNAV Document No. 41P4) in June 1978 by the Navy Energy Office (OP-413). The plan consists of an overview of energy conservation programs and accomplishments as well as an assessment of

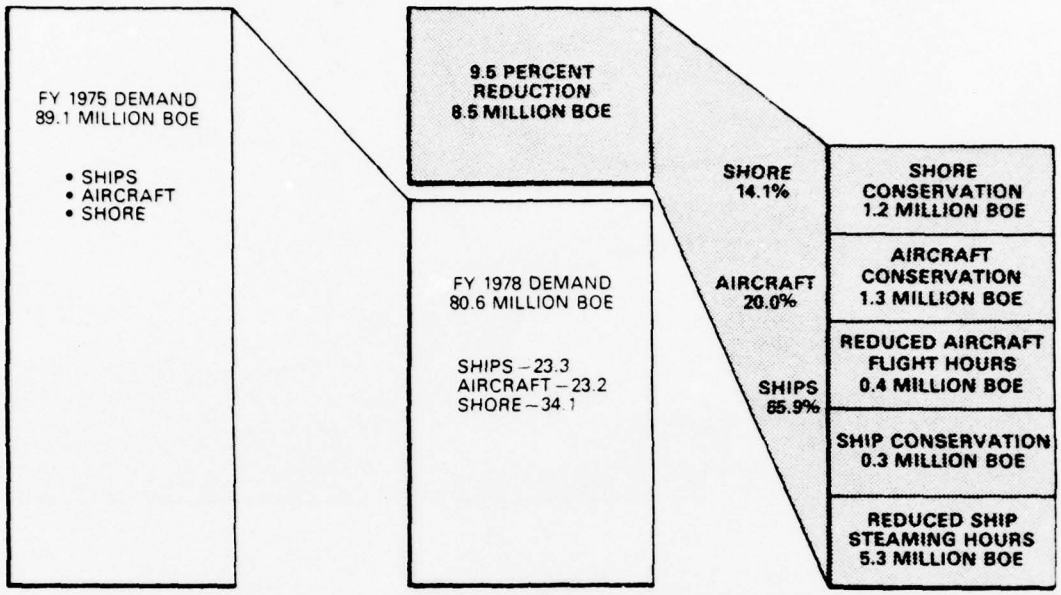


Figure 9. NAVY DIRECT ENERGY CONSERVATION PROFILE, FY 1978 (BARRELS OF OIL EQUIVALENT)

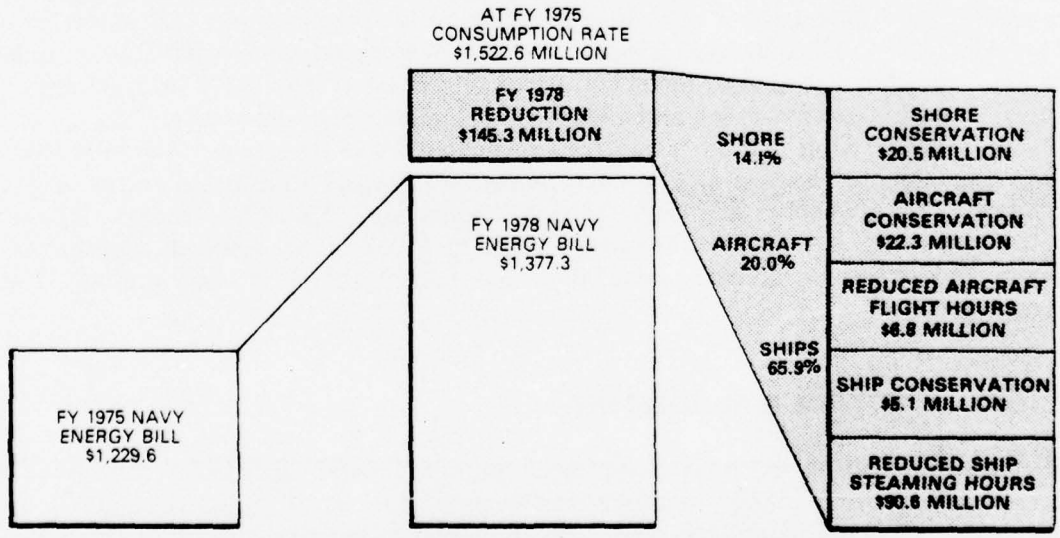
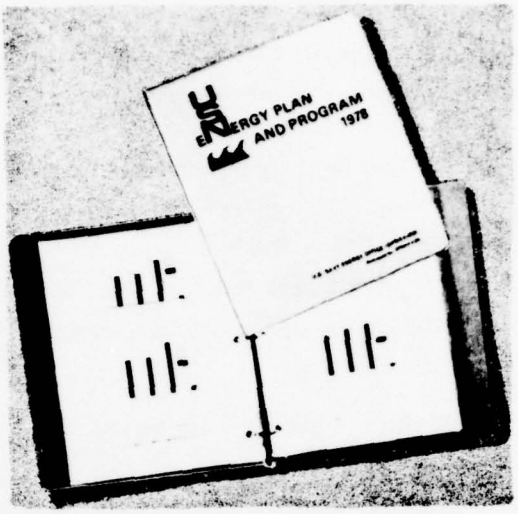


Figure 10. NAVY DIRECT ENERGY CONSERVATION PROFILE, FY 1978 (CURRENT DOLLARS)

the current and future world and national energy situation as it affects Navy and Marine Corps operation.



In the 1978 Navy *Energy Plan and Program,* the Navy established revised energy goals in conformance with OPNAVINST 4100.5A, and provided an annual report to the Secretary of the Navy (SECNAV) and the Office of the Secretary of Defense. The document also assisted the Systems Commands, program managers, and fleet and shore commanders in evaluating and implementing local policies and program activities.

The Navy Energy and Natural Resources R&D Office (MAT-08T3) published its annual U.S. Navy *Energy R&D Program Plan* in October 1978. This plan, developed with the assistance of the Systems Commands and laboratories, identifies and assesses promising technological solutions to the Navy's operational energy problems. It includes a description of ongoing and planned projects and resource requirements for FY 1979 through FY 1984.

ENERGY CONSERVATION AWARENESS

The Navy established, by SECNAV Instruction 4100.8, an annual energy conservation awards program as a means of recognizing those Navy and Marine Corps activities that are outstanding in energy conservation and resource management.

For the period FY 1973 through FY 1977, submissions for the awards were received from 52 Navy and eight Marine Corps activities. In October 1978, the Navy presented awards in each of seven categories:

- Large ships, awarded to USS John F. Kennedy (CV67).
- Small ships (crew less than 400), awarded to USS Blakely (FF 1072).
- Aviation squadrons, awarded to Air Test and Evaluation Squadron, VX-1, Patuxent River, Maryland.
- Large Navy shore activities, awarded to PMTC, Point Mugu, California.
- Small Navy shore activities (resident and nonresident base population under 500), awarded to NAVSECGRUACT, Winter Harbor, Maine.
- Marine Corps activities, awarded to MCAS, Iwakuni, Japan.
- Naval industrial facilities, awarded to Pearl Harbor Naval Shipyard, Pearl Harbor, Hawaii.

Winners of the FY 1978 awards were announced in June 1979, and include:

- Small ships, awarded to USS Arthur W. Radford (DD 968).
- Aviation squadrons, awarded to Fleet Composite Squadron Seven, VC-7, Alameda, California.
- Large Navy shore facilities, awarded to Naval Air Test Center, Patuxent River, Maryland.
- Small Navy shore facilities, awarded to Navy Regional Medical Center, Corpus Christi, Texas.
- Marine Corps activities, awarded to MCAS, Beaufort, South Carolina.
- Naval industrial facilities, awarded to Navy Public Works Center, Norfolk, Virginia.

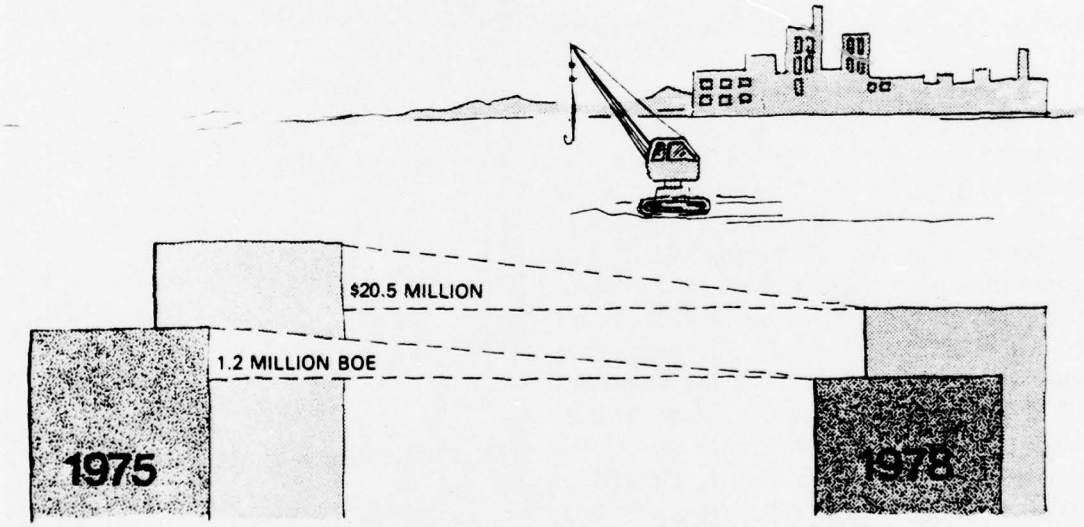
The winner in each category received a certificate of award, a distinctive plaque, and an official energy conservation awards flag to be flown until the next annual awards are announced.

The first annual Navy Department Energy Awareness Week was observed 23–27 October 1978. In preparation for this event, the Navy Energy Office prepared an Energy Awareness Planning Booklet (OPNAV No. 41P5) for distribution throughout the Navy and Marine Corps. The material in the booklet is designed to assist commanders, commanding officers, and their public affairs personnel to plan, organize, and conduct an effective program. The booklet includes information on planning an awareness week, publicity resources, milestones, energy-saving tips, and information sources.

The initial energy awareness week observances were highly successful in increasing the level of understanding of the present and future energy situation faced by the Navy Department. The activities provided an excellent means for publicizing Navy Department energy goals and for demonstrating many unique energy conservation and energy substitution programs.

SHORE FACILITIES PROGRAM

During FY 1978, the shore energy conservation program, including vehicles and ground support equipment, resulted in energy savings of 1.2 million BOE at an estimated cost savings of $20.5 million (1978 dollars), as compared to the FY 1975 baseline year. These savings resulted largely from increased energy awareness, improved energy resource management, the Energy Conservation Investment Program (ECIP), and use of more energy efficient vehicles.



Energy Conservation Investment Program

ECIP funding in FY 1978 was $26.1 million, and investment in the program since its inception in FY 1976 now totals $107.4 million. Annual energy cost savings now exceed $15 million and by 1985 should reach over $60 million. Completed projects include improvements to heating, ventilating, and air conditioning; energy monitoring and control; and electrical and lighting systems. Building alterations, such as the installation of air curtains and reduction of glass area, also have resulted in cost savings. Other ECIP projects that have resulted in significant energy savings include cross-connecting steam plants and providing condensate return lines; replacing outmoded boiler controls; and recovering waste heat from boiler stacks, motors, and incinerators.

Energy Engineering Program

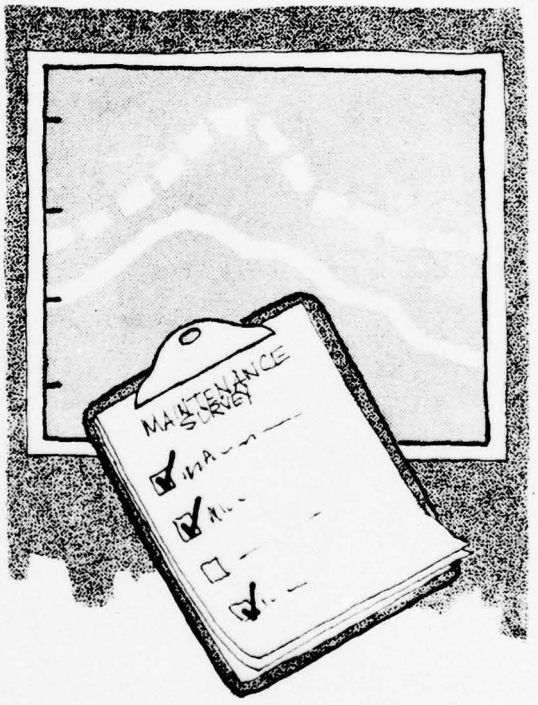
Naval Facilities Engineering Command (NAVFAC) has initiated direct data development and analysis to maximize the effectiveness of an Energy Engineering Program effort related to cogeneration, industrial facility retrofits, energy distribution system improvements, and heating and power plant optimization projects.

Energy Conservation and Management Program

An Energy Conservation and Management Program was initiated in FY 1978 to reduce energy usage at government-owned, contractor-operated facilities. The cognizant Engineering Field Divisions (EFD) have surveyed the Naval Shipyard, Philadelphia, Pennsylvania; the Naval Air Rework Facility, Norfolk, Virginia; the Naval Weapons Industrial Reserve Plant, Calverton, New York; and the Naval Industrial Reserve Ordnance Plant, Minneapolis, Minnesota.

Energy Monitoring and Control Systems

NAVFAC also has initiated efforts to investigate the applicability and economics of advanced Energy Monitoring and Control Systems (EMCS) to typical naval shore facilities. This effort includes development of guidance for retrofit of existing EMCS with modern microprocessor techniques and hardware, and the selection of an EMCS for retrofit at a specific site. Civil Engineering Laboratory (CEL) will, with the cognizant EFD, develop guidance and criteria for purchase of an EMCS retrofit package for the Navy Hospital in Long Beach, California, and translate FY 1978 experience into procedures for evaluation and design of other systems in FY 1979 and beyond.



Energy Cogeneration

Based on previous efforts, CEL, again with the cognizant EFD, has initiated an effort to select the most promising site for a cogeneration feasibility demonstration. CEL also has identified specific high technology elements and state-of-the-art techniques to be addressed.

Geothermal Resource Development

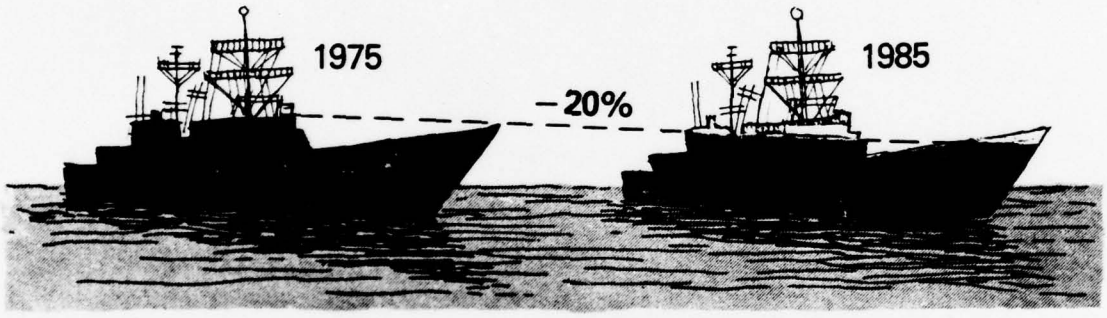
Several naval bases are located on or near economically promising geothermal resources that could provide electric power or space heating. The Coso thermal area at the Naval Weapons Center (NWC), China Lake, California, and a resource at Adak, Alaska, are areas of potential major development.

Geological/geophysical studies by U.S. Geological Survey (USGS) and other agencies are continuing at Coso. NWC will continue to monitor activities in the area and assemble data needed for Navy evaluation of the area.

At Adak, following extensive geophysical studies conducted by USGS, three holes were drilled; drilling of the first hole was terminated due to hole squeeze, but the hole was completed with a steel liner to enable measurement of heat flow. The second hole was drilled to 628 meters; the temperature recorded at 549 meters was 49°C. This hole was also completed with a steel liner, and temperatures are being monitored. The third hole has been abandoned.

SHIP OPERATIONS

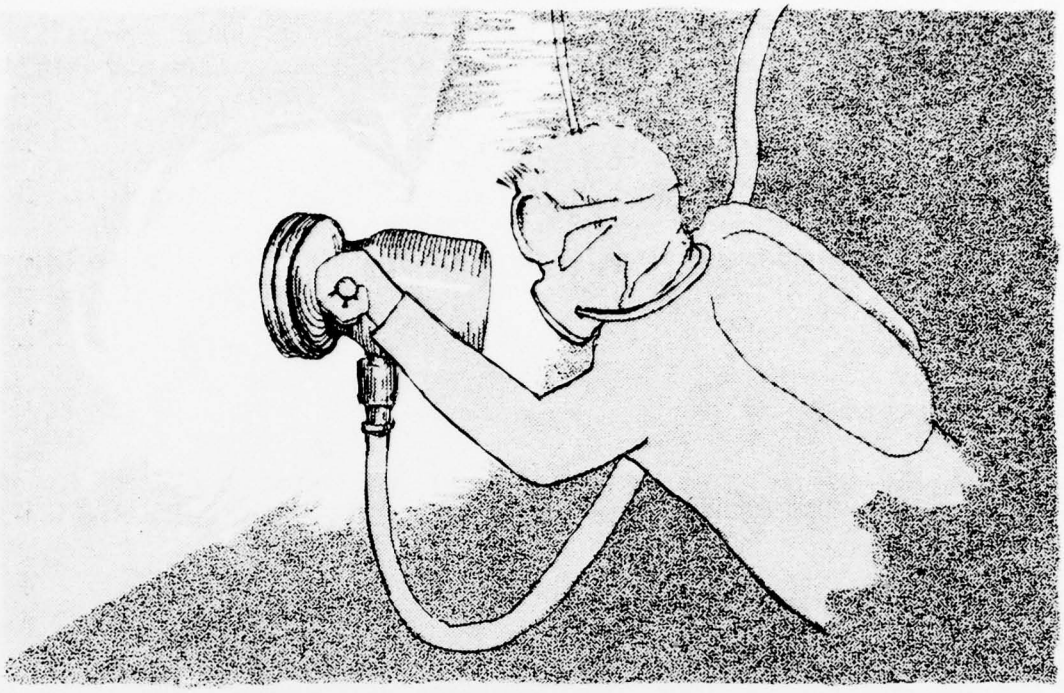
Navy Department ship energy usage for FY 1978 totaled 23.3 million BOE. Ship operations accounted for approximately 29 percent of the total energy used by the Navy in FY 1978.



The Navy is pursuing an intensive energy conservation R&D program in an effort to achieve an overall savings of 20 percent per steaming hour in FY 1985, based on average performance by ship class. The Navy has placed considerable emphasis on hull maintenance to include underwater hull and propeller cleaning, ultrasonic biofouling prevention, and use of organometallic polymer hull coatings.

Underwater Hull Cleaning

During FY 1978, the David W. Taylor Naval Ship R&D Center in Annapolis, Maryland, (DTNSRDC/A) completed all but one of four full-scale trials. These trials consisted of extended tests of the fouling rates and loss of efficiency for the USS Stein (FF 1065) and USS Whipple (FF 1062) in the Pacific, and the USS Blakely (FF 1072) and USS Trippe (FF 1075) in the Atlantic. The DTNSRDC/A determined that shaft horsepower per ton displacement to maintain 140 RPM without hull cleaning increased at a rate of 1.85 percent per month in the Pacific and 0.44 percent per month in the Atlantic.



Propeller fouling also can cause a significant loss of efficiency. For the three ships on which tests have been completed. the percent decrease in required power resulting from propeller cleaning is:

	At 140 RPM	At 16 knots
USS Whipple	14.8	29.5
USS Holt	5.4	10.3
USS Stein	7.7	11.1

These tests also demonstrated that the fuel penalty per ship depends directly on the thoroughness with which the hull and appendages are cleaned. Where the cleaning efficiency is considered to be 100 percent, the refouling rate is only 50 percent of that occurring where the cleaning efficiency is only 75 percent.

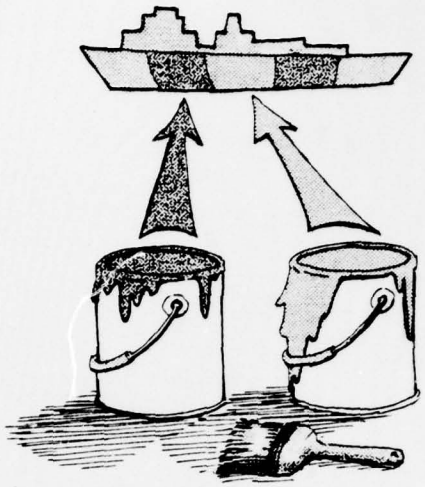
During FY 1978, DTNSRDC/A initiated a project to design an appendage cleaning system, began studies on paint wear and refouling studies, and issued interim cleaning instructions. To provide protection for the normally unpainted hull areas, DTNSRDC/A also initiated development of a dock block coating technique.

Ultrasonic Biofouling Prevention

The Navy has demonstrated, at least on an experimental basis, that it is feasible to use ultrasonic transducers to prevent or reduce biofouling in sea chests and other inaccessible areas. Initial laboratory tests have been completed on various transducer designs and operating parameters have been defined. Field tests were conducted on simulated sea chests submerged off Panama City, Florida, with favorable results.

Improved Hull Coatings

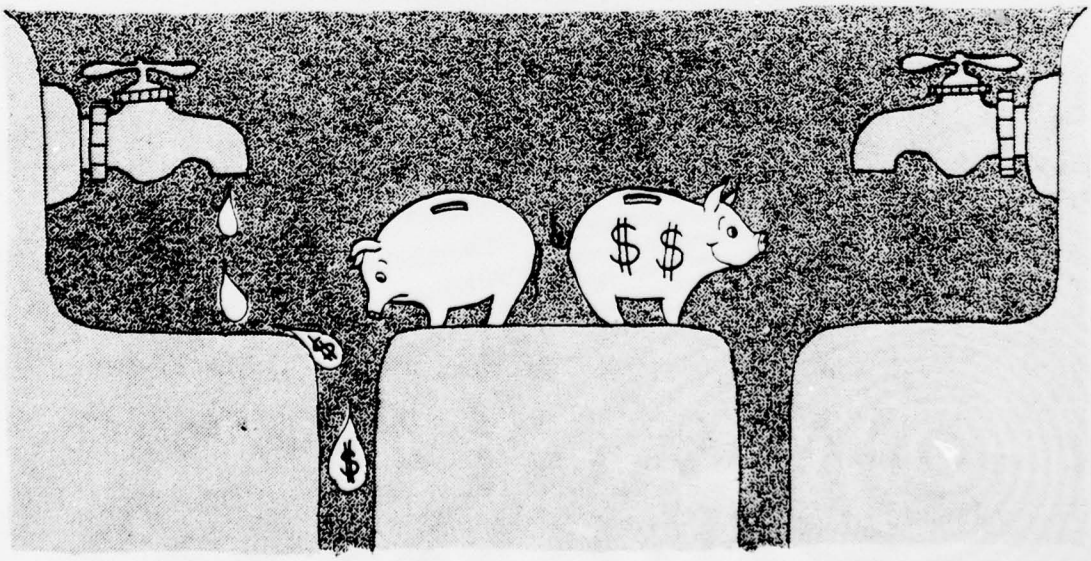
DTNSRDC/A has screened the initial organometallic polymer paint formulations and selected two candidates for ship trials. During FY 1978, DTNSRDC/A completed the trials plan, assembled a trials team, and assigned a West Coast ship to receive the first application in the early spring of 1979. DTNSRDC/A also continued to study those coatings that failed the early tests for possible second generation applications.



During FY 1978, the Navy evaluated over 20 plasma-sprayed high-performance polymers. Other special application coatings and elastomers also were investigated and the vulcanized bonding of antifouling rubber was evaluated for use as a propeller coating.

Water Resource Management

OPNAV Instruction 9330.5A allows consumption of 30 gallons of potable water per man-day aboard ship. This allotment is regularly exceeded by 10 to 20 gallons because of waste, increase in legitimate needs, and poor water management. A reduction in potable water consumption from 40 to 45 gallons per man-day to 20 to 25 gallons per man-day throughout the fleet would save $15 million annually. Use of reduced-flow shower heads, modified laundry procedures, and other water conservation measures have been introduced on the USS Saratoga and USS Patterson.

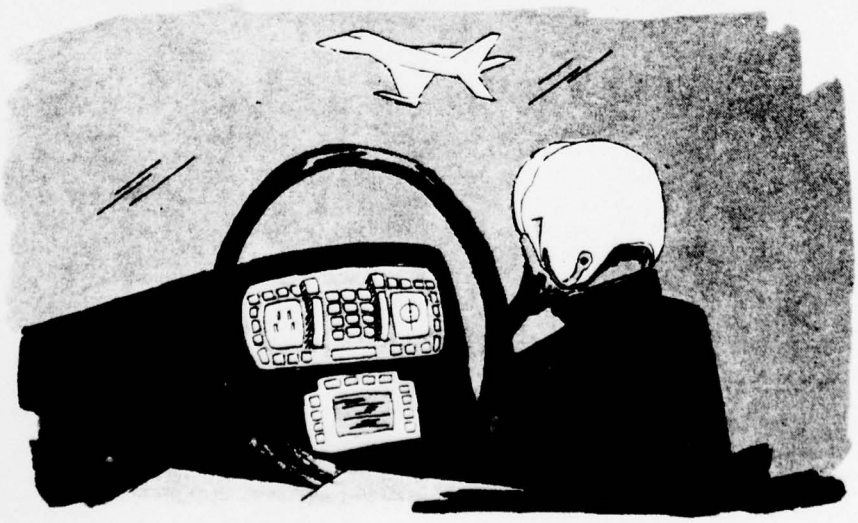


AIRCRAFT OPERATIONS

The Navy achieved significant savings in aircraft operations during FY 1978 through use of flight simulators and computer assisted flight planning. To identify and classify the principal fuel users, the Navy conducted fuel use surveys of 36 different types of Navy and Marine Corps aircraft.

Use of Flight Simulators

The Navy increasingly is emphasizing training aircraft crews (as well as ship's crews) in a simulated environment, in conjunction with training using operational equipment. Simulators are used to improve training effectiveness and maintain combat readiness while holding training costs to reasonable levels with significant material and personnel savings.



The Navy and Marine Corps use several types of training devices, some of which simulate a wartime environment that otherwise could be produced only through the highly expensive deployment of carriers and aircraft. These devices include weapon system trainers, night carrier landing trainers, flight instrument trainers, air-combat maneuvering simulators, and initial F-18 training devices. Use of these simulators in FY 1978 resulted in a savings of over 10,000 flights—a savings of approximately 1.8 million barrels of fuel costing about $30.4 million.

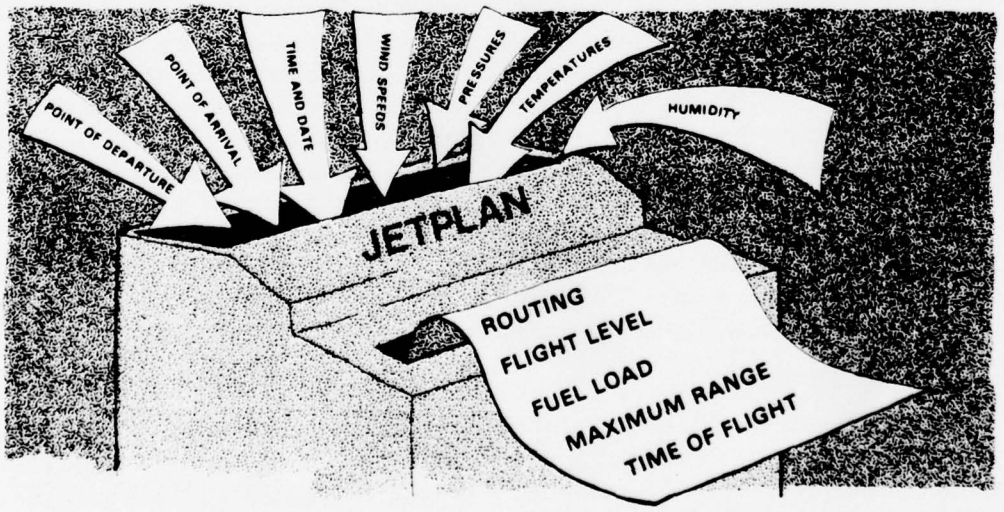
Computer Assisted Flight Planning

Efficient flight planning is vital to conserving fuel and realizing the maximum range from the fuel load. Using the assigned mission as the basis for the flight plan, several other factors, including atmospheric conditions, tactical and air traffic control situations, and safety, must be considered to yield the most efficient flight plan.

Since 1974, the Navy has used a computerized flight planning system developed by Lockheed, called Jetplan, to optimize routing flight levels and fuel loads for unclassified point-to-point flights. The program is accessed by remote terminals located at several naval air stations. The Naval Weather Service operates the terminals and prepares the flight plans.

Flight plans have been available at Moffett Field, Barbers Point, and Alameda since October 1974, and at Brunswick, Norfolk, and Jacksonville since April 1975. Also, Moffett Field and Brunswick can transmit flight plans via the autodin system to naval air stations all over the world. During FY 1978, approximately 88,000 barrels of fuel were conserved using Jetplan at a savings of about $1.6 million.

In July 1979, the Optimum Path Aircraft Routing System, a Navy computer program designed to replace Jetplan, will be completed and an in-house evaluation will be started.



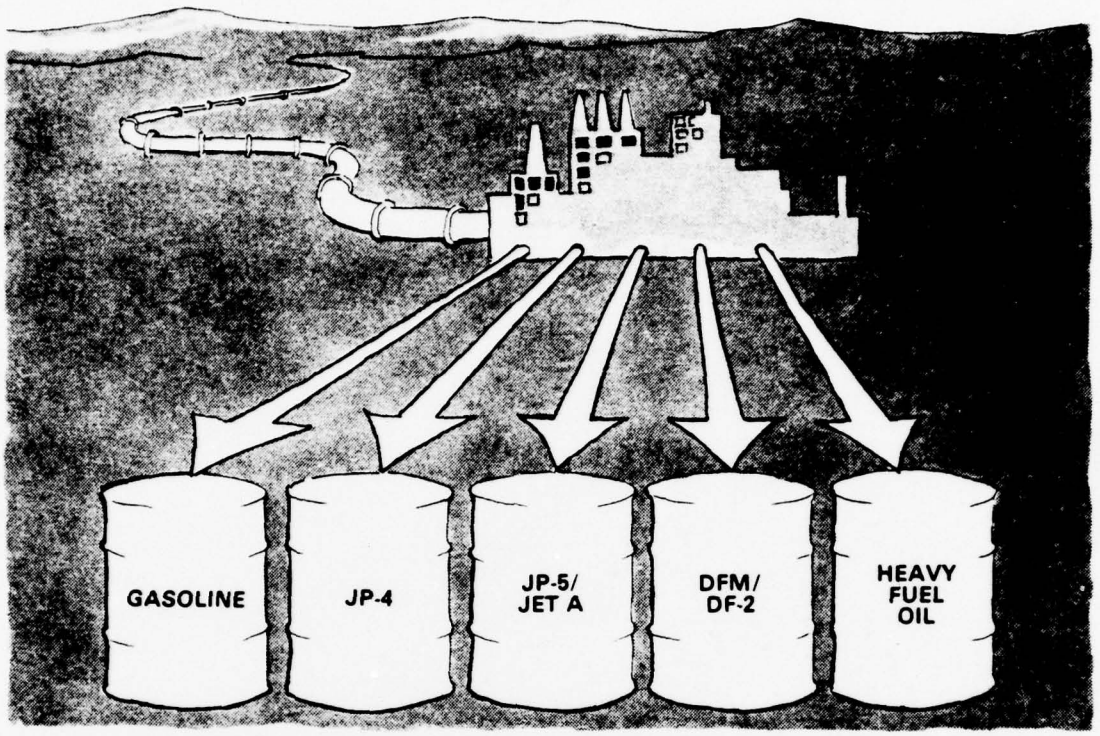
Fuel Use Survey

The Navy Department conducted a fuel use survey of 36 different types of Navy and Marine Corps aircraft in early FY 1978. This survey identified six aircraft types as the principal fuel users: F-4, P-3, A-4, A-6, A-7, and F-14, in order of total fuel consumed. These six types of aircraft consume approximately 75 percent of Navy and Marine Corps aircraft fuel. A review of inventory and naval aircraft planning documentation revealed that all of these aircraft types are in inventory in sufficient numbers and will be available long enough (beyond 1985) to warrant possible fuel-saving operational changes or physical modification. The Navy awarded fuel saving technology applications studies for the F-4 and P-3 to McDonnell Aircraft Corporation and Lockheed California Corporation to identify feasible aircraft modifications and determine associated consequences. Navy in-house studies were initiated for VP/VS (P-3/S-3) and VA/VF (A-6, A-7/F-4, F-14) operations in FY 1978.

USE OF SYNTHETIC FUELS

In 1974, the Navy served as the lead agency for a joint Department of Defense (DOD), Coast Guard, Maritime Administration (MARAD), Energy Research and Development Administration, and National Aeronautics and Space Administration (NASA) project to refine and test fuels derived from 10,000 barrels of crude shale oil produced by the Paraho surface retort process. The fuel types produced were gasoline, JP-4, JP-5/Jet A, DFM/DF-2, and heavy fuel oil. These fuels were tested at various government and industry laboratories. The tests culminated in the successful operational flight of a T-39 jet aircraft by the Air Force; the successful operational cruise of the Great Lakes steamer, Edward B. Green, sponsored by the Navy, MARAD, and Coast Guard; and the operational testing of a jeep engine (L-141) by the Army. These tests demonstrated the feasibility of using crude shale oil as a feedstock for military fuels, particularly those in the middle-distillate range (jet and marine fuels).

As a follow-on to the 10,000 barrel shale oil refining and testing project, the Navy presently is serving as the contracting agency and project director for a joint DOD-Department of Energy (DOE)-NASA program to acquire, refine, and test shale oil produced by the Paraho process on the Naval Oil Shale Reserves near Rifle, Colorado.



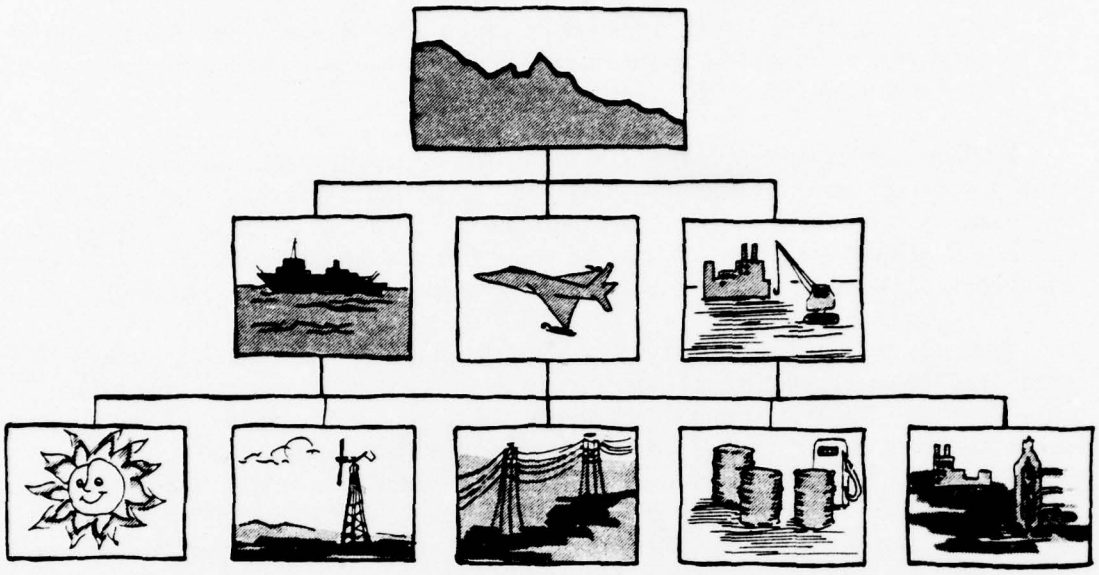
From January 1977 through September 1978, a total of 88,225 barrels of crude shale oil was produced under Navy and DOE contracts. In late October 1978, 72,500 barrels of this shale crude was delivered to the SOHIO refinery at Toledo, Ohio, where, under Navy contract, the crude was refined into 30,000 barrels of military fuels for testing by the military services and other federal agencies. Basically, the refining process consisted of first stage hydrotreating/hydrocracking followed by fractional distillation to various fuel products. Final nitrogen removal was accomplished by acid treating and clay filtration. These fuels are being shipped to various laboratories for further testing.

The Navy has conducted atmospheric sampling to determine the concentration and characteristics of hydrocarbon vapors in the working spaces aboard ships. The data will be used to estimate the concentrations to be expected when synthetic fuels are used. The U.S. Naval Medical R&D Command is examining candidate synthetic liquid fuels for possible toxic effects. The results of this work, when combined with vapor concentration estimates, will be used to determine potential health effects and provide the basis for any recommended procedures or precautions that may be needed when operating with synthetic fuels.

The Navy is testing mixtures of waste fuels and fresh fuel oils in shore boilers. The boiler test facility for synthetic fuels and waste oil blends, located at the Civil Engineering Laboratory in Port Hueneme, California, consists of two open air burners, one 200 HP water tube and one 30 HP boiler. These boilers are fully equipped with stack emission and performance measuring instrumentation. The Navy is also conducting systematic tests and evaluations of various synthetic fuels as they become available to determine fuel properties;

fuel handling, preparation, and safety techniques; necessary modifications to boiler and fuel supply systems; and long term operating and maintenance considerations.

The synthetic fuels program for ship and aircraft operations is designed to develop a capability to utilize fuels derived wholly or in part from domestically produced synthetic crudes in existing Navy ships and aircraft by the mid-1980s. Major hardware changes are assumed to be impractical before this time.



ENERGY MANAGEMENT ORGANIZATION

The Assistant Secretary of Defense (ASD) for Manpower, Reserve Affairs and Logistics (MRA&L), is the principal Department of Defense (DOD) energy conservation officer. His deputy, the Deputy Assistant Secretary of Defense (DASD) for Energy, Environment and Safety (EES), is responsible for energy policy and is the focal point for all DOD energy matters. The Director for Energy Policy (DEP), under the DASD(EES), is responsible for policy formulation in matters of energy conservation, management, supply, and technology applications.

The Defense Energy Policy Council (DEPC) provides the DASD(EES) with the means to coordinate energy policy at the highest level as well as contribute valuable feedback on energy programs and problems. The DEPC comprises senior staff elements in the Office of the Secretary of Defense, the energy focal points of the military departments, the organization of the Joint Chiefs of Staff, and the Defense Logistics Agency. A lower level group, the Defense Energy Action Group, enables the DEPC to develop energy policy.

In addition to the DASD(EES), there are two other elements in the Office of the Secretary of Defense involved with energy conservation through their program management responsibilities:

- The DASD for Installations and Housing (I&H), also a deputy to the ASD(MRA&L), provides overall project management of the military construction

program. In this capacity, the DASD(I&H) is the focal point for the energy conservation investment program (ECIP).

- The Office of the Under Secretary of Defense for Research and Engineering has management responsibility for research and development and the energy conservation and management (ECAM) program.

Each military department has a special assistant for energy matters as well as an energy office to operate departmental energy programs and take lead action, when assigned, in designated areas of interest to all military departments. In each of the military services, commanders at all levels are responsible for the development and maintenance of effective command energy programs. Figure 11 outlines energy management responsibility in DOD.

The Defense Energy Program Policy Memorandum, No. 78-6, dated 2 October 1978, announced the DOD assignment of lead service responsibilities for energy technologies. The responsibilities of a lead military department are to establish coordination mechanisms; develop coordinated DOD-wide program plans, objectives, and implementation responsibilities; and encourage, through the DEPC, emphasis on the most important areas. In addition, a designated lead military department promotes efficient use of DOD resources; sponsors the development of specifications, standards, handbooks, or other mechanisms to promote the beneficial use of energy technologies; and provides for technology transfer to include the exchange of information. The Navy Department was designated the lead military service for geothermal energy (heat and electrical power), cogeneration and total energy systems, energy monitoring and control systems, multifuel and high efficiency ship propulsion systems, and refuse-derived fuels.

Within the Department of the Navy, energy management responsibility is carried out through the existing military chain of command (see Figure 12). The Secretary of the Navy directs the Chief of Naval Operations (CNO) and Commandant of the Marine Corps (CMC) to achieve certain energy reductions. The CNO and CMC then direct the major claimants, the facilities real property holders, to achieve these goals, and the major claimants in turn direct their subordinate activities to take specific energy conservation actions.

Navy energy resource management responsibilities are primarily vested in the Deputy CNO for Logistics (OP-04) who provides policy coordination and guidance related to energy matters. The Director of the Material Division (OP-41) provides the principal staff support for energy matters and serves as chairman of the CNO Energy Action Group.

The Navy Energy Office is responsible to OP-41 for planning and monitoring efficient use of energy throughout the Navy. The Navy Energy Office also provides policy guidance on all matters pertaining to energy and energy conservation, except those relating to nuclear energy; ensures that the Navy can provide the required energy resources to the operating forces and shore establishments; coordinates with the Office of the CNO and acts as a central point of contact for Navy energy and energy conservation matters (other than nuclear energy); and participates in functions of interdepartmental interest pertaining to energy matters.

The Director of Research, Development, Test and Evaluation (RDT&E) OP-098, carries out the CNO's RDT&E responsibilities and assists the Assistant Secretary of the Navy

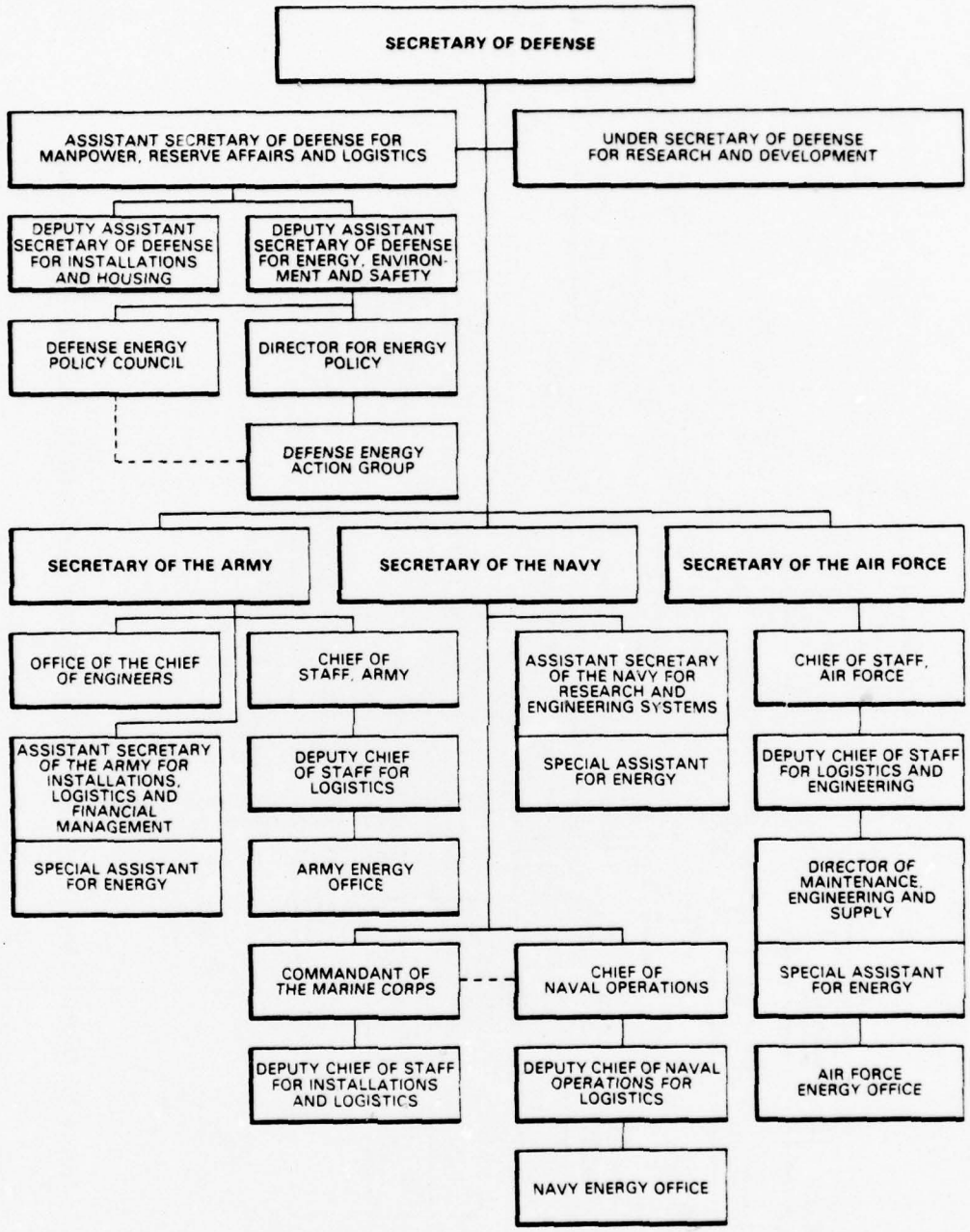


Figure 11. DEPARTMENT OF DEFENSE ENERGY MANAGEMENT RESPONSIBILITY

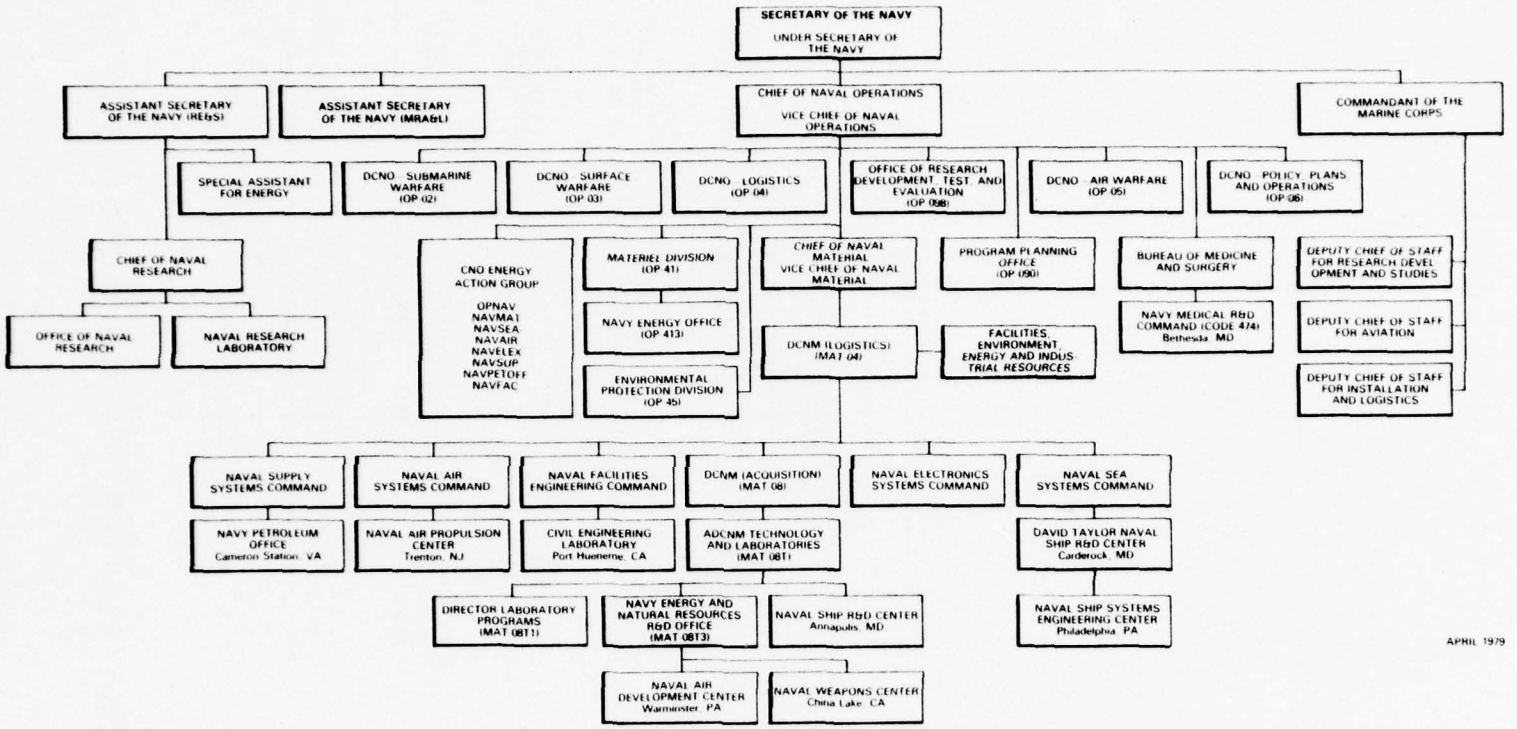


Figure 12. DEPARTMENT OF THE NAVY ENERGY MANAGEMENT ORGANIZATION

(ASN) for Research, Engineering and Systems (RE&S) with the coordination, integration, and direction of the Navy RDT&E program. The Director of RDT&E supervises and coordinates submission of the Program Objectives Memorandum, the RDT&E budget authorization request, and the Five Year Development Plan update. The Director of RDT&E is the principal supporting witness for the ASN (RE&S) before congressional committees. In addition, the Director makes presentations and provides descriptive summaries and other requested material to Navy staff elements to further explain and support specific R&D programs.

The Development Coordinator for all Navy energy R&D programs, OP-098G, is responsible for accomplishing all RDT&E actions at the Naval Operations (OPNAV) level associated with the approved program. The main function of the Development Coordinator is to review energy-related R&D documents for accuracy, completeness, and applicability to total Navy R&D requirements. In addition, the Development Coordinator ensures that required R&D documents are submitted on time and that funding profiles reflect energy requirements that are attainable, given the total R&D budget.

The Deputy Chief of Naval Material for Logistics (MAT-04) is the senior staff officer of the Naval Material Command (NAVMAT), reporting to the CNO on all matters associated with energy management. His responsibilities encompass implementing policy and directing the overall energy management program within NAVMAT and for coordinating the program specifically assigned to other Chief of Naval Material offices and activities. In the exercise of this responsibility, the Assistant Deputy Chief of Naval Material for Facilities, Environment, Energy and Industrial Resources (MAT-044) acts as the coordinator for the program.

The Director of the Navy Energy and Natural Resources R&D Office (MAT-08T3) supervises the planning, execution, and appraisal of NAVMAT's energy and natural resources exploratory, advanced, and engineering development programs. To fulfill its responsibilities, the Navy Energy and Natural Resources R&D staff must review all Navy programs involving energy technology evolution or applications to assess the feasibility of achieving program goals, the validity of the technical approach, the adequacy of management and funding to accomplish these goals, the feasibility of proposed schedules, and the progress and future prospects of the programs.

The Navy Energy and Natural Resources R&D Office sponsors experiments and demonstrations in the application of the technological advances resulting from energy R&D efforts sponsored by the Navy, other military departments and federal agencies, and private industry. Through these efforts, such technological developments can be applied within the Navy as quickly as possible.

The Naval Facilities Engineering Command (NAVFAC) provides guidance, direction, and technical expertise to assist the Navy and Marine Corps shore activities in achieving their energy goals. It operates through six geographic Engineering Field Divisions, which act as field offices to provide specific engineering support to naval activities within their area. Also, nine public work centers (PWCs) provide utilities, maintenance, and transportation support. PWCs are located in Norfolk, Virginia; Pensacola, Florida; Great Lakes, Illinois; San Diego and San Francisco, California; Pearl Harbor, Hawaii; Guam; Subic Bay, Philippines; and Yokosuka, Japan.

NAVFAC also sponsors the ECIP, the Energy Engineering Program, and the naval shore facilities R&D program. Under the direction of NAVFAC, an energy R&D program management office has been established at the Civil Engineering Laboratories at Port Hueneme, California.

In July 1975, the Naval Sea Systems Command (NAVSEA) assigned responsibility for ship energy R&D to the David W. Taylor Naval Ship R&D Center (DTNSRDC). An energy R&D program management office was established at DTNSRDC, Annapolis, to work closely with the Naval Ship Engineering Center in Philadelphia, other Navy laboratories, and other federal government activities. The NAVSEA energy program office has identified efforts required to fulfill the goals for reduction in shipboard energy usage, and has developed programs and detailed program plans to meet these goals.

The Naval Air Systems Command (NAVAIR) has assigned overall responsibility for coordinating the NAVAIR energy program to the Deputy Commander for Plans and Programs (AIR-01). The Executive Director of Management Plans and Programs has collateral duty, as the NAVAIR energy coordinator, to task functional groups in NAVAIR and field activities for the required technical support, and to maintain liaison with OPNAV, NAVMAT, and other energy-related organizations.

The Marine Corps Deputy Chief of Staff (DC/S) for Installations and Logistics (I&L) is responsible for implementing the Marine Corps energy conservation program. The DC/S for I&L establishes energy conservation criteria, develops program elements, monitors achievements, and takes corrective action as required to achieve desired results regarding utilities energy and vehicle fuels conservation. The DC/S for I&L also monitors usage of aviation and tactical fuels at Marine Corps activities. The DC/S for Research, Development and Studies is the development coordinator for all Marine Corps energy R&D programs and is responsible for accomplishing all approved research, development, test, and evaluation action of unique Marine Corps equipment. The DC/S for Aviation and the DC/S for Research, Development and Studies coordinate aviation and R&D energy conservation as they relate to Marine Corps matters.

DEPARTMENT OF THE NAVY ENERGY PROGRAM

The Navy Department has established energy goals, which are promulgated in OPNAVINST 4100.5A and MCO 4100.4, to establish and maintain a well balanced energy program, responsive to federal and defense energy policy guidelines. Accomplishment of the Navy's energy goals will contribute to the national energy conservation effort and will ensure that the overall energy resources of the Navy are adequate to meet its current operational needs in a world of increasingly scarce petroleum and natural gas resources.

The Navy Department energy program comprises energy resource management, energy distribution and allocation, energy utilization and conservation, use of synthetic fuels, and development of alternative energy sources. The energy resource management and energy distribution and allocation program areas are discussed as they relate to all naval operations. Energy utilization and conservation, synthetic fuels, and alternative energy sources, however, are presented under specific operational area headings, including shore facilities, ship operations, and aircraft operations. In its energy resource management actions, the Navy seeks to achieve maximum practical energy conservation for facilities and operations, emphasizing conservation of petroleum-derived fuels and natural gas; substitution, when economically feasible, of alternative, more abundant, or renewable energy sources where liquid hydrocarbon and natural gas now are used; and consideration of the effect of energy policies and actions on the health and safety of Navy personnel and the environment. Energy resource management includes development of a comprehensive energy program and

plan, conduct of energy awareness and related activities, and a continued review of actions taken throughout the Navy Department to minimize the adverse effect of energy-related problems.

To ensure that there will be no mission degradation caused by domestic or worldwide energy shortage, the Navy's energy distribution and allocation program includes a worldwide fuel and materials logistics system that can efficiently furnish the necessary energy supplies in the form and quantity required. Energy utilization and conservation is directed at eliminating wasteful energy use, developing more efficient power and propulsion equipment, and improving basic energy systems to use less fuel.

Efforts within the synthetic fuels program include conducting laboratory tests and evaluations of the use of synthetic fuels in existing Navy equipment, leading to utilization of products of the emerging synthetic fuels industry as soon as these products are commercially available. The alternative energy sources program involves developing local renewable energy resources such as solar, wind, geothermal, and refuse-derived fuel at both remote and domestic bases; and, where possible, replacing liquid hydrocarbon fuels with more abundant fuels such as coal. The objective is to test and evaluate alternative and advanced energy systems to reduce the use of petroleum products.

The Navy Department will measure the accomplishment of energy goals at the activity level except where noted. Unless otherwise stated, the goals that apply to the reduction or savings in the use of energy, from the FY 1975 baseline (1 October 1974 through 30 September 1975), by the end of 1985 are:

- *Reduction of 20 percent in existing facilities per gross square foot of building floor area.*
- Reduction of 45 percent in new facilities per gross square foot of building floor area, to be achieved through new construction design specifications.
- Savings of 15 percent in fuel consumption by ground support equipment.
- Reduction of 20 percent in fossil fuel consumption per ship underway steaming hour.
- Reduction of 90 percent in fleet and shore surveys (measured at the overall Navy level).
- Reduction of 5 percent in fuel consumption per flight hour.
- Savings of 9 percent in fuel consumption through simulator substitution.
- Substitution of coal, solid waste, refuse-derived fuels, and biomass for 10 percent of the 1985 installation energy used ashore (measured at the overall Navy Department level).
- Substitution of solar and geothermal energy for 1 percent of the 1985 installation energy used ashore (measured at the overall Navy Department level).

ENERGY RESOURCE MANAGEMENT

Navy Department energy resource management focuses on providing innovative

management of energy programs and reducing organizational shortcomings. It also provides planning for the short, middle, and long terms and for improving coordination of energy matters among the Navy Department and the Department of Defense (DOD), Department of Energy (DOE), and other federal agencies. New programs that are necessary to minimize adverse effects of the present and future energy situation are established and continually reviewed.

Long-range planning and lead time are two of the most critical elements that will affect the Navy Department's energy status. Generally, budget procedures, organizational structures, and planning processes operate within the established Planning, Programming and Budgeting System (PPBS) and annual budgets as included in the Five Year Development Plan (FYDP). Federal legislation requires all federal agencies to submit 10-year conservation plans. However, planning and managing energy-related activities must span decades if optimum results are to be achieved. For example, major shore station conversion from natural gas to coal and implementation of waste energy recovery systems are long-term goals that may require 10 to 20 years for full implementation.

The DOD energy management process—the Defense Energy Management Cycle (DEMC)—is designed to obtain maximum energy management effectiveness and is tied directly to the established PPBS. The DEMC provides a mechanism for integrating an annual energy program review; annual updates of the DOD, military department, and agency energy plans; and the DOE report requirements.

The annual program review is conducted in coordination with the Defense Energy Policy Council (DEPC) and the Defense Energy Action Group (DEAG). The review includes examination of mobility and operation and installation energy conservation, supply goals, and performance; the impact of the next fiscal year budget decisions and the military department and agency proposals in the next Program Objectives Memorandum (POM); and any additional executive or legislative mandates. Decisions made during the annual program review are reflected in revisions to the DOD energy plan.

The DOD 10-year energy plan is revised each July to reflect current goals and objectives and provide the basis for the next fiscal year's program review. The purpose of this plan is to:

- Give preliminary programming guidance to the military departments and defense agencies several months in advance of formal Consolidated Guidance (CG).
- Provide the basis for Energy, Environment and Safety (EES) input to the CG for the forthcoming program year.
- Provide a baseline of information on overall DOD energy goals, progress, and plans.
- Comply with annual DOE reporting requirements.

The military departments and defense agencies update the energy plans each January to reflect the latest budget decisions and policy guidance.

DOD energy policy guidance is contained in DOD directives. Based on these directives and on advice from the DEPC, the Deputy Assistant Secretary of Defense (DASD) for EES

issues Defense Energy Program Policy Memoranda (DEPPMs), which provide specific policy guidance on:

- Energy priorities.
- Basic goals and timeframes for their accomplishment.
- Energy management actions.
- Assignment of lead responsibility for various aspects of the overall DOD energy program.
- Guidelines for preparation of energy management plans.
- Other guidance for the implementation of the DOD energy programs.

During FY 1978, the Navy Department continued to refine its energy conservation goals and improve its energy resource management activities. Well-defined energy program and energy R&D plans were prepared and supporting studies and implementing instructions completed. This energy resource management effort included:

- Publication of the U.S. Navy *Energy Plan and Program— 1978,* Navy Energy Office (OP-413), June 1978.
- Publication of the U.S. Navy *Energy R&D Program Plan, FY 1979-FY 1984,* Navy Energy R&D Office (MAT-08T3), October 1978.
- Publication of the U.S. Navy *Energy R&D Progress Report,* Navy Energy R&D Office (MAT-08T3), March 1978.
- Awarding of the first annual Secretary of the Navy Energy Conservation Awards, September 1978.
- Implementation of the first annual Navy Department Energy Awareness Week, October 1978.
- Publication of the *Shipboard Energy R&D Plan, FY 1978-83,* Naval Sea Systems Command, July 1978.
- Publication of the *Draft Navy Shore Facilities Energy R&D Plan for FY 1980,* Naval Facilities Engineering Command/Civil Engineering Laboratories, April 1979.
- Publication of the Department of the Navy *Energy Management Annual Report—FY 1978-1979,* Navy Energy Office (OP-413) June 1979.

Navy Energy Plan and Program

A Navy energy plan and program is prepared annually to report on the progress made in achieving defined energy utilization and conservation goals. The plan includes an overview of organization and accomplishments as well as a best assessment of the current and future world and national energy situation as it affects both Navy and Marine Corps operations. The plan is submitted to the Office of the Secretary of Defense (OSD) and becomes an attachment to the annual DOD energy report to the Secretary of Energy.

The Navy *Energy Plan and Program—1978* established revised Navy energy goals in conformance with Naval Operations (OPNAV) Instruction 4100.5A. It included a report on the Navy energy situation in reference to these goals, summarized energy-related

accomplishments since the inception of the program in FY 1978, and summarized the military construction (MILCON), operations and maintenance (O&M), and research, development, test and evaluation (RDT&E) plans and resource requirements through 1985. The plan and program document, in addition to providing a status report to the Secretary of the Navy (SECNAV), assists program managers and fleet and shore commanders in evaluating and implementing local policies and program activities. (The plan does not include a consideration of nuclear energy; nuclear energy-related activities are the responsibility of other Chief of Naval Operations (CNO) offices.)

Navy Energy R&D Program Plan

The Navy energy R&D program supports the overall Navy energy program directed by the Navy Energy Office. The Navy Energy and Natural Resources R&D Office (MAT-08T3) developed the FY 1978 program plan, assisted by the Systems Commands (SYSCOMs) and laboratories. This document identifies and assesses promising technological solutions to the Navy's operational energy problems.

The current R&D program plan includes a description of ongoing and planned projects and resource requirements for FY 1979 through FY 1984. These projects are discussed in terms of three strategies: energy conservation, synthetic fuels, and alternative energy sources.

Navy Energy R&D Progress Report

The FY 1977 U.S. Navy *Energy R&D Progress Report,* the fifth in a series of periodic reports summarizing the Navy's R&D accomplishments, was distributed in March 1978. The project status descriptions were based on reviews presented by the Navy SYSCOMs and laboratories, and emphasized progress from October 1977 through December 1977.

Energy Awareness Activities

Energy awareness activities are a key part of Navy energy management. These activities include the SECNAV energy awards program, the Navy Department Energy Awareness Week, a Navy Department incentives award program, and publication of energy resource management guidelines.

SECNAV Energy Conservation Awards Program

SECNAV Instruction 4100.8 established an annual energy conservation awards program as a means of recognizing Navy and Marine Corps activities with outstanding energy conservation and energy resource management programs. Submissions for the FY 1978 annual awards were received from 23 Navy and five Marine Corps activities. Awards will be presented each year in seven categories as discussed on page 26.

Department of the Navy Energy Awareness Week

Energy Awareness Week is a period set aside each year in accordance with SECNAVINST 4100.8 and OPNAVINST 4100.7 for all Navy and Marine Corps activities to

examine the critical role energy plays in the operational readiness of the naval services and study the energy supply problems of the nation and the Navy Department in particular. Energy Awareness Week also offers the opportunity to discuss what the naval services are doing and can do to meet their energy program objectives, and reemphasize the need for energy conservation.

The Navy Energy Office (OP-413) sponsors the event and provides guidance, support, and resource information to Navy and Marine Corps units and activities for implementing Energy Awareness Week at the command level.

The first annual Department of the Navy Energy Awareness Week was observed 23–27 October 1978. Feedback from the command level indicates that the event was successful in increasing the level of understanding among military and civilian personnel of the current and future energy situation faced by the Navy Department, and of Navy energy programs, goals, and R&D efforts.

Preparations are under way for the second annual Energy Awareness Week, scheduled for 22–28 October 1979. The theme of this year's Energy Awareness Week is "Saving Energy: Everybody's Job," emphasizing the fact that effective conservation results only from the cumulative effect of everyone's individual effort to use energy responsibly.

An Energy Awareness Week planning booklet will be provided to every Navy and Marine Corps command in early September. It will contain specific ideas for implementing the event and sources of additional ideas, films, and materials to support local observances. The Energy Awareness Week theme poster will accompany the planning booklet. A package of ready-to-use articles, notices, and artwork appropriate for ship or station newspapers, local newspapers, and plans of the day will be sent to editors throughout the Navy and Marine Corps by mid-September. In August, Direction Magazine will publish an article for Public Affairs Officers containing suggestions on how to publicize Energy Awareness Week effectively. A bulletin will be issued to all commanders and commanding officers to encourage active command level support of local Energy Awareness Week observances. The 1979 plan for implementing Energy Awareness Week is designed to encourage responsible energy use throughout the Navy community.

Navy Department Incentives Award Program

The federal government employees incentive awards program was established to improve government operations and acknowledge the achievements of employees. SECNAV has delegated responsibility for the overall administration of the Navy program to the Director of Civilian Manpower Management, who establishes policy, issues standards, grants exceptions, disseminates contributions to DOD and other federal agencies, and consolidates required reports. Also, the Navy Department Incentive Awards Board has been created to assist in attaining program objectives. The present incentives award program will include special recognition for improved energy resources management.

Energy Resources Management Guidelines

An energy resources management manual, being prepared under the direction of the Navy Energy Office, will help energy officers throughout the Navy Department gain a better understanding of the opportunities for effective energy conservation and resource management. The manual provides guidelines for organizing, planning, and managing an effective energy conservation program, and includes a technical discussion of energy conservation opportunities (compiled from numerous government and industry publications as well as documents published by the SYSCOMs).

Energy Management Training

The Civil Engineering Corps Officers' School (CECOS) conducts a 1-week energy management course to train operational and survey personnel. Conducted three times per year (alternating on each coast), the course is taught by the CECOS staff from Port Hueneme, California, supplemented with lecturers from the Naval Facilities Engineering Command (NAVFAC) and private industry. Also, NAVFAC's Engineering Field Divisions (EFDs) conduct regional seminars and provide for interchanges of management techniques and updates on Navy energy management policy. A NAVFAC correspondence course for utility system operators was published in 1976 to assist in energy conservation, especially in the area of boiler plant operations.

Energy awareness and energy conservation instruction is included in the curricula at both the Naval Academy at Annapolis, Maryland, and the Naval Post Graduate School at Monterey, California. This instruction includes a review of the present and future energy situation as it affects the Navy and provides indoctrination in the need for energy conservation and the use of alternative energy sources.

The Navy Systems Acquisition Management Course consists of 5 days of instruction and case studies relating to the Weapon System Acquisition Process. The course emphasizes the management application of the many disciplines and techniques used in the acquisition process and policy and guidance put forth in the major DOD directives (for example, DOD 5000.1 and DOD 5000.2), including consideration of energy usage and efficiency. Presentations include Navy project management philosophy; major systems acquisition; OPNAV program management, test, and evaluation; manpower resource utilization; applied logistics; and supply support.

U.S. Navy policy requires all military personnel to be aware of the world energy situation and to exercise energy conservation in all aspects of their jobs and personal lives. It has been proposed that formal training be included at least once during a General Military Training Cycle. Information will be continually provided through Plans of the Day notes, base or ship newspapers, internal television and radio program spots, and other internal public affairs media. Particular emphasis on conservation and awareness will be applied during Navy Energy Awareness Week in October of each year.

Special Marine Corps energy management training programs include energy/utilities management surveys and utilities engineer workshops.

Energy Information Systems

Information related to fuel and energy consumption is obtained through the Defense Energy Information System (DEIS), Navy Energy Usage Profile and Analysis System (NEUPAS), a Utilities Cost Analysis Report, and special reports as required.

Defense Energy Information System

During the Arab oil embargo of 1973-74, DOD determined that timely and accurate energy inventories and consumption information were restricted entirely to bulk fuel terminal operations. The exigencies of the situation required definitive information from all levels regarding individual base, unit, and activity energy inventories and consumption. In response to this energy information requirement, the DEIS was developed.

The Defense Fuel Supply Center (DFSC) maintains and updates DEIS-I for shipboard, aircraft, and ground support energy consumption, and DEIS-II for military installations and shore facilities. The Navy Petroleum Office monitors the final DEIS-I report for Navy activities to ensure that the data are accurate and complete, and supplies special summary reports for CNO. All major claimants must fill out and submit DEIS-I report forms monthly. DFSC receives these reports and puts them into the DEIS-I automated data bank. The computerized system then generates monthly compilations of the use of the various standard fuel types by each of the services. The program categorizes data according to several breakdowns and summarizes overall fuel use.

NAVFAC is the Navy program coordinator for DEIS-II and provides quality control, activity guidelines, and an analysis of the data to CNO. DEIS-II provides quarterly reports, by energy type, of baseline consumption, current period consumption, Navy funded consumption, and cost for utilities energy. Entries are by month, with quarterly totals. Information from these reports is forwarded to major claimants for monitoring energy conservation achievements and utilities energy cost trends.

Marine Corps headquarters (Code LFF-2) manages the program for Marine Corps DEIS-I and DEIS-II reports.

Revised DEIS guidelines were published 5 October 1978 as OPNAVINST 4100.8 and MCO 4100.9.

Navy Energy Usage Profile and Analysis System

NEUPAS was designed to provide historical patterns of energy usage (included in Appendix A). In addition, NEUPAS uses the historical energy usage data to predict future Navy energy requirements. This system is a compilation of the end-user fuel and utility energy consumption reports, operational hours reports, and current force-level data. The data are supplemented with projected force levels, unit energy usage characteristics, and energy cost information to support the predictive analysis.

The Energy Usage Projection Program forecasts total annual Navy operational energy

usage and costs through FY 2000, based on projected force levels, energy cost, and unit consumption. Shore energy usage projections for this plan are generated by NAVFAC.

Utilities Cost Analysis Report

The Navy's utility management report, "Utilities Cost Analysis Report" (NC-2127), is used by performing activities to compute the unit cost of utility services produced, purchased, and distributed to the user activities. The report is also used by NAVFAC, the performing activities, EFDs, and major claimants for evaluating the efficiency of utility operations, the effectiveness of utility system management, and as a basis for preparing the utility O&M budgets. The report is the basic tool for assuring an equitable distribution of utility expenses to the consumers and effective management of the utility systems.

ENERGY DISTRIBUTION AND ALLOCATION

The energy distribution and allocation program is designed to ensure that the appropriate mix of energy supplies is available where needed in sufficient quantities to support the required tempo of operation. This program area includes petroleum, oil and lubricants (POL) training, fuel management systems, Prepositioned War Reserve Material Requirements (PWRMR), and contingency planning.

Petroleum, Oil and Lubricants Training

The Navy uses about 60 million barrels of fuel per year, including POL for almost 500 ships, 5,000 aircraft, and all Navy shore facilities. The volume and diversity of petroleum products require Navy personnel to be trained in procurement, quality assurance, and operational procedures and techniques for handling ship propulsion and aviation fuels.

The Navy currently conducts fuel distribution training at the U.S. Army Quartermaster School, Fort Lee, Virginia. Additionally, a bulk fuel system course, tailored toward naval shore facilities requirements, has been developed by the Commander in Chief, Pacific Fleet. Information regarding this course may be obtained from the Naval Petroleum Training Unit of the U.S. Pacific Fleet, Naval Supply Center, 937 Harbor Drive North, San Diego, California 92132.

Fuel Management Systems

The systems that supply bulk petroleum products to the Navy and Marine Corps include:

- Underway replenishment system, which supplies bulk fuel to the fleet.
- DOD terminal system, which supplies wartime stocks to satisfy PWRMR and peacetime operating stocks.
- At-sea transportation system, which transfers POL from commercial production facilities to designated storage sites.
- Shore transportation system, which supplies continental United States (CONUS) terminals and bases.

- Fuel management system, which procures bulk petroleum products and manages the above components.

The worldwide DOD fuel management system, including procurement, has been assigned to the DFSC of the Defense Logistics Agency (DLA). The Military Sealift Command (MSC) furnishes tactical air observers, which are under fleet command and function in the same manner as U.S. Navy air observers. The MSC also acts as the waterborne fuel transportation agent.

Basic petroleum management policies are contained in DOD Directive 5105.22, DLA and DOD Directive 4140.25, and DOD Manual 4140.25-M, "Procedures for the Management of Petroleum Products," dated December 1978. Policy guidance also is provided in OPNAVINST 4020.25, dated 10 February 1978, which outlines requirements for developing local procedures for managing and controlling ground fuel products at the station and unit level of each naval establishment. This instruction was prepared in response to a General Accounting Office (GAO) audit that revealed serious procedural weaknesses and inadequate control over ground fuel products. Minimum basic control requirements include validation of quality and quantity of fuel on receipt of an order, supplier's invoice (by sampling, gauging, and/or metering), and deliveries and disbursement. Physical inventories of stocks on hand are conducted at least once a week.

Prepositioned War Reserve Material Requirements

PWRMR are part of the mobilization reserve material needs that are positioned at or near the point of planned use, or issued to the user, before hostilities begin. This ensures timely support of specific projects or designated forces during the initial phase of war until normal resupply is established. Some of the most important components of PWRMR are bulk petroleum products to be used by the active Navy, Naval Reserve Forces, MSC, Coast Guard, and Marine Corps. The PWRMR program, maintained by CNO (OP-413), determines annual POL requirements for ships, aircraft, CNO special projects, and overseas shore bases. The Assistant Secretary of Defense for Manpower, Reserve Affairs and Logistics, DFSC, CNO, Commandant of the Marine Corps (CMC), and fleet commanders share responsibility for specifying requirements, designating the location and level of terminals to store PWRM stocks, provisioning PWRM stocks to designated terminals, and managing the system.

The computer model used to determine the annual PWRMR receives inputs from the Ship Management Information System, the Aircraft Program Data File, and consumption rate information taken from actual historical data. The Marine Corps also determines and provides its requirements as an input to the model. The program is updated to include the latest defense policy and planning guidance and planning and programming guidance memoranda. PWRMR methodology is an enclosure to OPNAVINST S4020.15H of 31 January 1975.

Contingency Planning

DOD Instruction 4170.9, Defense Contractor Energy Shortages and Conservation,

dated 16 May 1978, assigns responsibilities and provides guidance for dealing with industrial energy shortages that affect defense production. This instruction, promulgated as OPNAVINST 4100.9, dated 12 January 1979, also encourages energy conservation among defense contractors.

A DLA plan, "Bulk POL Support during an Arab Oil Embargo" (DLA OPLAN 1-77), was approved in May 1977. The plan provides for continuing bulk POL support to the military services in the event of an embargo of crude oil, refined products, or both by Arab oil-producing nations. Primary reliance will be on prepared standby orders placed with industry. Based on the circumstances at the time of any embargo, DFSC will evaluate immediate-type actions, cargo diversions, alternate lifts, accelerated deliveries, and redistribution of assets as approved by the Joint Chiefs of Staff and the Commanders in Chief.

Local contingency plans and knowledge of available policy and procedures are necessary to minimize the impact of future energy supply disruption. Local contingency plans are receiving renewed emphasis also as part of the ongoing energy conservation surveys. Most Navy activities, dependent on fuel from the same commercial suppliers as private industry, may have natural gas deliveries curtailed. In addition, they are subject to power distribution outages and receive low voltages during brownouts. Preparation for such contingencies requires estimates of quantities of fuel and electricity consumed by each building at an activity, so that reduction actions can be quantitatively determined prior to last-minute interruption.

OPNAVINST 4100.6 (Energy Source Selection and Criteria for Shore Facilities), MCO 11370.1A (Additional Fuel Criteria), and DOD Instruction 4140.25 (Management of Bulk Petroleum Products, Facilities and Services) direct that a 30-day oil storage capability, based on the oil requirement for the coldest 30 days) be maintained at all oil fired plants or plants with oil standby, and that all natural gas fired plants with a capacity of 5 million Btu per hour and greater be modified to be capable of burning fuel oil.

SHORE OPERATIONS

The basic objective of the shore program is to provide naval shore activities with the technical expertise and assistance needed to achieve the energy conservation and alternative fuels goals promulgated in OPNAVINST 4100.5A and MCO 4100.4. The Navy's energy program for shore activities, one of the Navy's primary energy consumption areas, is recognized at all levels as a top priority effort. NAVFAC acts as the shore energy conservation program manager for Navy activities. For Marine Corps activities, the Deputy Chief of Staff for Installations and Logistics serves as the energy conservation program manager.

The challenge of meeting energy conservation goals in the Navy's shore program, including Navy and Marine Corps facilities (active and reserve), government-owned, contractor-operated (GOCO) plants, cold iron support to ships, and use of ground support equipment such as transportation vehicles, is directly related to the various conditions under which shore facilities and ground vehicles operate. This challenge is being met by a comprehensive program structured to satisfy mission requirements while systematically applying economic criteria, such as payback and cost/benefit analyses, to identify and select new technology and energy alternatives.

Energy Conservation

The energy conservation program for shore facilities involves eliminating wasteful energy use and improving the energy efficiency of existing or planned buildings and ground support equipment. Energy conservation includes: energy conservation surveys of existing buildings; Energy Conservation Investment Program (ECIP); Energy Engineering Program (EEP); Energy Conservation and Management Program (ECAM); boiler tune-up program; family housing energy conservation; family housing utility metering program; planning, engineering, and designing more energy efficient facilities; vehicle energy conservation; and energy conservation research and development.

ECIP projects evolve from energy conservation surveys by NAVFAC EFD representatives or from the local base utilities personnel. The projects flow through the regular Shore Installation Facilities Planning and Program System (SIFPPS) and are given priority by NAVFAC headquarters according to Btu's saved per thousand dollars invested.

Policy and procedural guidelines to implement and continue the Navy-wide energy management program for shore operations, excluding GOCOs, is contained in OPNAVINST 4100.5A, MCO 4100.4, and MCO-P 1100.9. The ECAM program was established for GOCOs in accordance with instructions promulgated by DOD in March 1978.

Total utilities expense and total expected savings in the Navy's currently funded facilities energy conservation programs are shown in Figure 13. The two curves show annual utilities expense with and without the proposed energy conservation programs. The curve plotted without energy conservation assumes that the mix of energy used after 1978 will not change from the 1978 mix (i.e., no increased use of coal, no decreased use of POL, no use of renewable energy, etc.). Based on these assumptions, in 1985 utilities expense without a con-

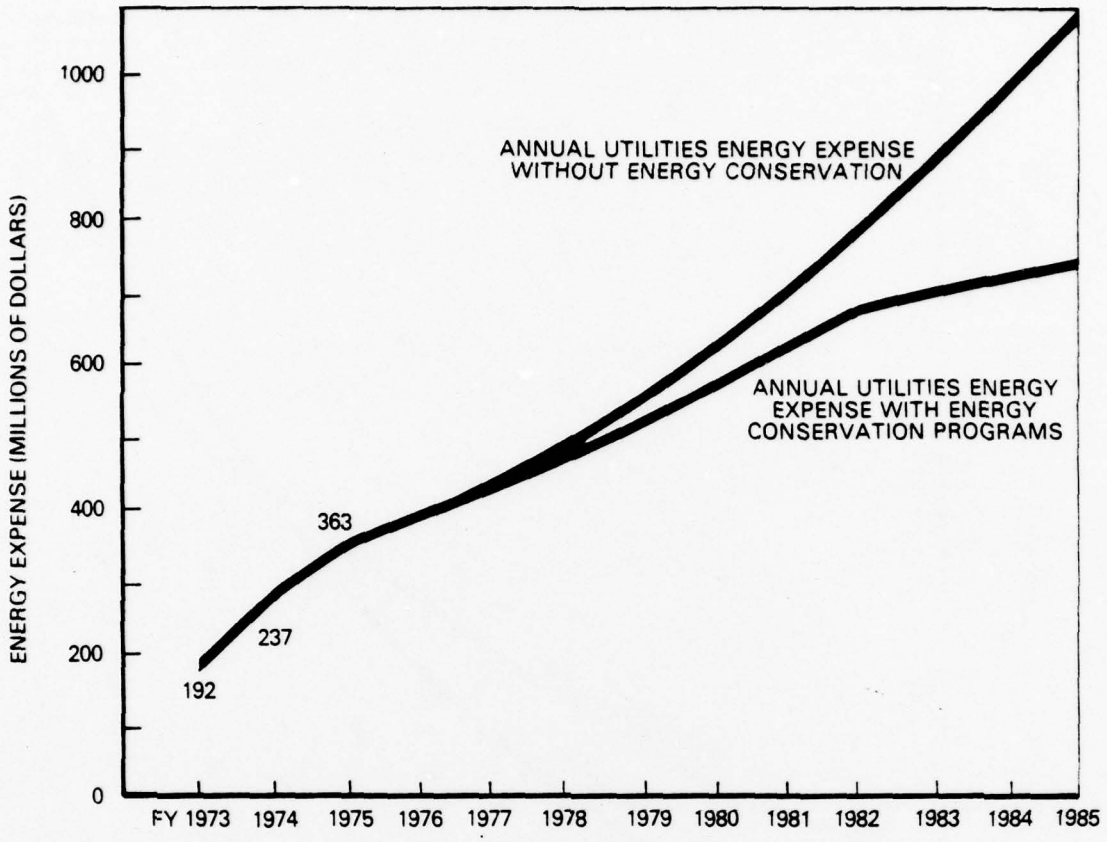


Figure 13. NAVY AND MARINE CORPS ENERGY CONSERVATION INVESTMENT PROGRAM SAVINGS FOR SHORE FACILITIES

servation program would increase to $1,100 million, or $365 million above the projected cost with a conservation program. Beyond 1985, utilities savings should continue at a level of several hundred million dollars per year.

Figure 14 is derived from Figure 13 and shows the potential cumulative energy savings in dollars plotted against the cumulative investment in the energy engineering and conservation investment programs. This figure indicates that savings escalate as energy costs increase. Early in 1983, a break-even point occurs at the estimated time when the total dollars invested in energy conservation will be repaid by energy dollars saved. By 1985 it is expected that cumulative savings will be $600 million, exceeding cumulative investment in shore conservation programs by $200 million.

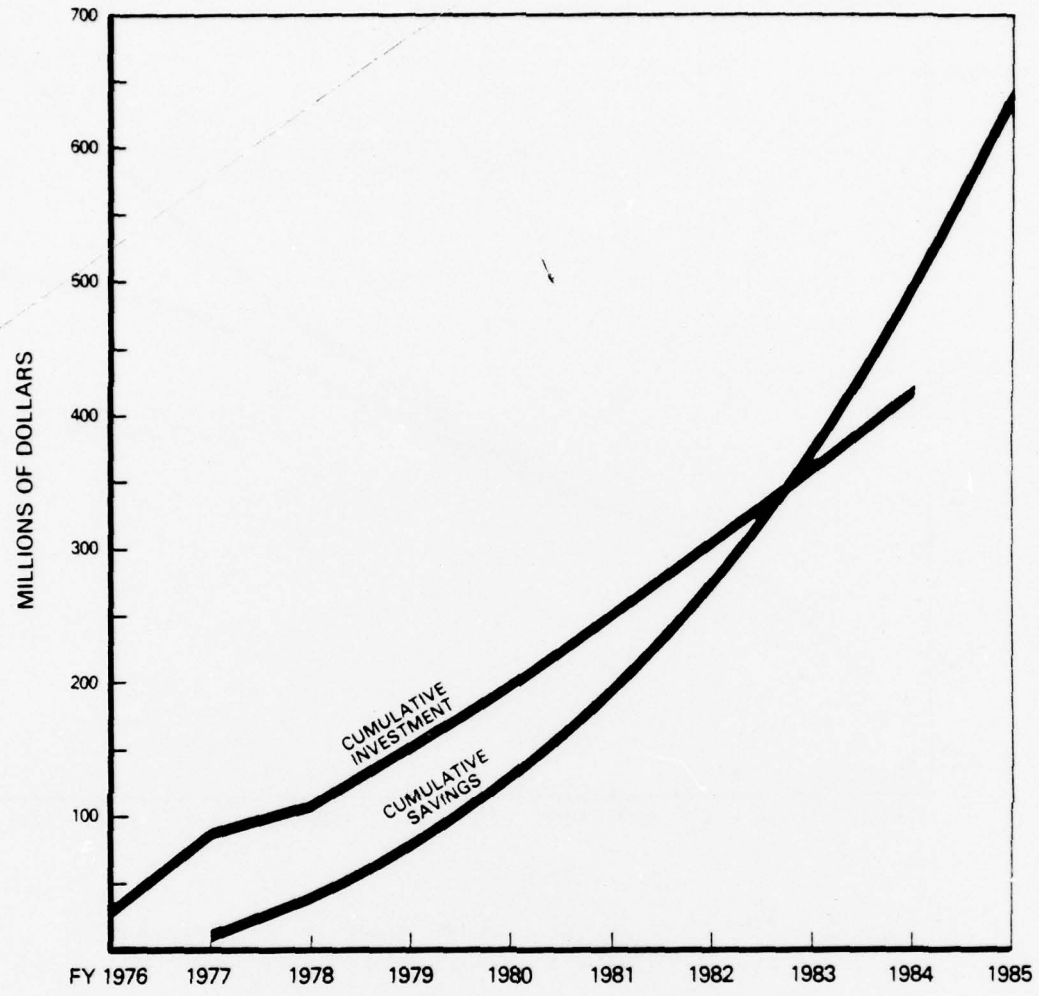


Figure 14. NAVY AND MARINE CORPS ENERGY CONSERVATION PROGRAM INVESTMENT VERSUS SAVINGS

Energy Conservation Surveys of Existing Buildings

Shortly after the 1973 oil embargo, the utilities division of the NAVFAC EFDs embarked upon an energy conservation survey program of all naval activities. During the completed Phase I effort, NAVFAC sent out survey teams to identify wasteful practices and help activities to develop individual energy conservation and contingency plans. Equally important, the teams also developed or helped the activities to develop self-amortizing repair and retrofit projects for accomplishment within the activity commander's budget, the major claimant's project budget limits, and the Navy's ECIP MILCON budget. Phase II, to be completed in FY 1979, is a series of revisits, primarily to seek out and develop capital investment projects of a more complex and technically sophisticated nature.

A third or fourth survey will be appropriate at the larger activities, for as the price of energy continues to increase, so does the opportunity for early payback project identification. These surveys also are addressing increasingly complex technical areas of conservation, such as industrial processes, heat recovery techniques, and the use of less conventional energy sources. These surveys will be followed by surveys performed under the EEP to identify additional projects in specialized technical areas.

Energy Conservation Investment Program

The MILCON ECIP provides for retrofit of existing facilities to minimize energy loss, utilize the latest energy-saving materials and equipment, and maximize the efficiency of existing energy systems to ensure the most efficient operations.

ECIP funding in FY 1978 was $26.1 million. Total investment in the program since its inception in FY 1976 now totals $107.4 million and annual energy cost savings now exceed $15 million and by 1985 should reach over $60 million.

Criteria used to determine eligible projects for ECIP funding include:

- Restriction of ECIP projects to retrofit of existing facilities.
- Cost-effectiveness of all projects, i.e., a savings-to-investment ratio (SIR) greater than one based on life-cycle cost analysis.
- Minimum energy savings-to-cost ratio of (million Btu saved per $1,000 of investment): FY 1979—23, FY 1980—22, FY 1981—20, FY 1982—19, FY 1983—18, FY 1984—17.
- A provision that up to 10 percent of the program can be for facilities outside CONUS (effective with the FY 1981 program).
- A provision that ECIP projects should combine similar work in various buildings. (Major individual projects may include dissimilar work.)
- A provision that the lead activity or public works center should prepare and sponsor the project when a basewide ECIP project affects more than one claimant.
- A provision that ECIP projects shall be supported with engineering calculations in sufficient detail to allow validation of estimated energy savings.

Projects which meet the above criteria and are candidates for ECIP funding are forwarded to NAVFAC by means of the SIFPPS for consideration. The projects that meet the above criteria are prioritized according to their energy savings-to-cost ratio.

In the ECIP program, the types of modifications and repairs being implemented include:

- *Steam and Condensate System Modifications.* Install condensate return lines, cross-connect lines, and looped systems to permit plant shutdown and sectionalized line shutdown during low-load summer months. Existing lines will be rehabilitated, including improved insulation and steam flow metering and controls.
- *Boiler Plant Modifications.* Modify boiler controls and boiler water treatment

facilities, and install facilities to burn refuse-derived fuel.

- *Lighting Conversion.* Replace incandescent fixtures with sources such as high pressure sodium vapor, which has approximately six times the light output per watt as the comparable incandescent fixture. Other innovations include selective controls, timers, and photoelectric cells.
- *Solar.* Install equipment to collect and apply solar energy to domestic hot water, space heating, and low temperature processes.
- *Electrical Energy Conservation.* Provide scheduling controls for electrical systems, combined loads on generators, and other methods for reducing the consumption of electrical energy.
- *Heating, Ventilating, and Air Conditioning (HVAC).* Install more efficient HVAC systems to provide necessary environmental control while greatly reducing energy requirements. Some examples are: replacing inefficient and wasteful controls, adding controls where there are none, and replacing entire systems.
- *Energy Monitoring and Control.* Install systems that include a central processing unit which has sensors and controls. Based on sensor readings and other conditions, controls are actuated according to a programmed strategy to decrease energy demands and consumption. These systems also have potential savings in use of maintenance and watch personnel.
- *Heat Recovery.* Recover and reuse heat that would otherwise be lost to the environment.
- *Insulation and Storm Windows.* Install storm windows and insulation in existing buildings.
- *Building Alterations.* Combine projects containing more than one of the above category retrofits, or retrofits that do not fall into one of these categories, such as air curtains.

Projects selected for the FY 1979 ECIP include:

Steam and Condensate Systems	NSY Norfolk, VA (2)
Boiler Plant Modifications	NWC China Lake, CA NAS Brunswick, ME NPWC Great Lakes, IL NAS North Island, CA
Lighting Systems	MCLSBLANT Albany, GA NAPTC Trenton, NJ NSPCC Mechanicsburg, PA NSC Norfolk, VA NSY Charleston, SC NPWC Pearl Harbor, HI MCB Camp Lejeune, NC
Heating, Ventilating, and Air Conditioning	NPGS Monterey, CA MCLSBLANT Albany, GA

	NSY Portsmouth, ME
	NSCS Athens, GA
	NAS Pensacola, FL
	NPWC Great Lakes, IL
	NWSC Crane, IN
	NAF Indianapolis, IN
Energy Monitoring and Control Systems	MCAS Cherry Point, NC
	NTC Orlando, FL
	NWSC Crane, IN
	NAS Cecil Field, FL
	MCB Camp Lejeune, NC
	PMTC Point Mugu, CA
	NPWC Norfolk, VA
	NATC Patuxent River, MD
	NSY Mare Island, CA
	NAS Memphis, TN
	NWC China Lake, CA
	NWS Charleston, SC
	NAS Jacksonville, FL
	MCB Camp Pendleton, NC
	NAS Pensacola, FL
Energy Recovery Systems	NSY Long Beach, CA
	NS Adak, AK
Insulation and Storm Windows	NAS Pensacola, FL
	NAS Brunswick, ME
	NSY Puget Sound, WA
	NOS Indian Head, MD
	MCLSBLANT Albany, GA
	NA Annapolis, MD
	NS Norfolk, VA
Building Alterations	NCS Cutler, ME
	NETC Newport, RI
	NS Pearl Harbor, HI
	NTTC San Francisco, CA
	NAS Cecil Field, FL
	NPWC Great Lakes, IL
	NAPTC Trenton, NJ
	NSPCC Mechanicsburg, PA
	FTC San Diego, CA

Energy Engineering Program

The EEP, managed by NAVFAC, is a new Navy-wide program to develop permanent technical measures to conserve energy through identification and development of high

technology projects. This program will complement the ECIP and ECAM to ensure that all possible practical energy conservation actions are initiated. EEP, funded by Operations and Maintenance, Navy (O&M,N), will pay for itself within 5 years and result in an estimated cost avoidance of over $18 million annually by 1985.

The program also will contribute toward accomplishment of the goals of OPNAVINST 4100.5A and assure reliable energy engineering support for naval shore activities. A parallel effort in this program is engineering assistance provided to the shore activities that are converting from natural gas and fuel oil to coal and nonfossil energy sources, such as solar energy, refuse-derived fuel, and geothermal energy.

The elements which make up the new initiatives in the NAVFAC managed EEP include:

- *Cogeneration/Total Energy Systems.* Conduct a program to evaluate cogeneration plant application to provide the majority of electricity and/or steam for large Navy industrial bases. Evaluate satellite energy requirements and apply spot cogeneration, heat recovery, and cascaded energy conversion systems to meet localized energy requirements.
- *Industrial Energy Retrofits.* Identify and implement opportunities to reduce energy consumption at Navy industrial activities.
- *Energy Monitoring and Control Systems (EMCS).* Develop and apply methodology to determine and acquire optimum EMCS for each shore activity.
- *Industrial/Boiler Water Treatment.* Improve control procedures to minimize thermal loss from 3,500 Navy boilers and improve life expectancy for 200 central air conditioning plants.
- *Air Conditioning Tune-up.* Develop and implement an air conditioning tune-up program (ACT-UP) to improve the operation and maintenance of 175 major air conditioning plants with capacities over 50 tons. This effort will include hands-on inspection, project development, and operator training.
- *Heating and Cooling Operator and Mechanic Training.* Provide system-specific training for all operators and mechanics. Develop programs to train all new personnel as well as retrain existing personnel in the latest techniques. RDT&E support to determine type, location, and extent of training is required to implement this program.
- *Energy Efficiency Indices.* Improve and extend energy efficiency indices currently under development by public works centers and shipyards to other facilities. Provide the management capability to effectively monitor and control indices and direct energy conservation actions, as required.
- *Energy Distribution System Improvements.* Provide the required mechanical utility distribution system expertise to survey and provide a complete picture of utility distribution systems throughout the Navy. Upgrade selected systems by installing controls and engineering condensate return systems where feasible.
- *Alternative Energy Sources.* Apply developing techniques and methodology to existing and new facilities to conserve and utilize energy resources in the most effi-

cient manner. Such nonfossil applications as solar, wind, geothermal, refuse-derived fuels, waste heat reclamation, etc., are included.

- *Heating and Power Plant Optimization.* Develop and implement a program to improve the thermal efficiency of Navy central steam and/or electric plants by upgrading equipment and controls, correcting operational and maintenance deficiencies, and providing enhanced personnel training.
- *Energy Technology Applications Program (ETAP).* Provide for the accomplishment of energy conservation retrofit projects with high dollar and energy payback which are not eligible for funding under ECIP because the investment cost is less than the current MILCON funding limit.

Because much preliminary work was needed to prepare for the effective use of these funds in FY 1979, $1.425 million in RDT&E funds were committed in FY 1978. These RDT&E funds were used to develop guidelines for and prototypes of six key elements of the EEP, including:

	Funding (Thousands of dollars)
Air conditioning tune-up	200
Statistical studies	130
Industrial surveys	350
GOCO surveys	175
EMCS	450
Cogeneration	120
Total	1,425

NAVFAC initiated a comprehensive pilot survey to identify specific high potential air conditioning system energy conservation opportunities. For the FY 1979 air conditioning efforts, NAVFAC developed specific high payback actions to be taken and developed guidance procedures.

NAVFAC has also initiated efforts to investigate the applicability and economics of high technology EMCS systems to typical naval shore facilities. This effort includes development of guidance for retrofit of existing EMCS with modern microprocessor techniques and hardware, and the selection of an EMCS for retrofit at a specific site. The Civil Engineering Laboratory (CEL) will, in concert with the cognizant EFD, develop guidance and criteria for purchase of an EMCS retrofit package for Naval Hospital Long Beach, California, and translate FY 1978 experience into procedures for evaluation and design of other systems in FY 1979 and beyond.

Based on previous efforts CEL, with the cognizant EFD, has initiated an effort to select the most promising site for a cogeneration feasibility demonstration. CEL has identified specific high technology elements and state-of-the-art techniques to be addressed by the contractor.

Energy Conservation and Management Program

In March 1978, DOD established the ECAM program for GOCO plants. This program, sponsored by the Chief of Naval Material, is designed to achieve the objective of Executive Order 12003 in further reducing energy usage at government owned facilities. An effective ECAM program will also further reduce material procurement costs resulting from increased overhead attributable to wasted energy.

Funding for the energy conservation projects for GOCO plants will be included in production base support or industrial facility budgets. All budget estimates for ECAM projects will be supported by economic analyses consistent with guidelines contained in the Office of Management and Budget (OMB) Circular No. A-94 and DOD Instruction 7041.3.

Comprehensive plans, which will be updated annually, are being developed for investment in energy conservation measures at each GOCO plant. NAVFAC has arranged to conduct energy surveys at Naval Industrial Reserve Ordnance Plant, Minneapolis, and Grumman Bethpage GOCO facilities, as possible candidates for the FY 1981 budget submission.

Industrial activities consume more than 22 percent of shore energy. Naval shipyards, Naval Air Rework Facilities, and GOCO facilities dominate the list of major utility users in the Navy. Energy resource management efforts in the private industrial sector indicate that utility savings of 20 to 35 percent may be realized through such practices as improved work scheduling, basic conservation efforts, modifications to HVAC systems, and improved industrial processes.

Boiler Tune-Up Program

The Navy Department initiated the boiler tune-up program to improve the operation of 650 shore boiler plants, assure compliance with air-emission regulatory standards, and increase combustion and thermal efficiency to the greatest degree possible. This program includes all stationary shore boilers with capacities of over 5 million Btu per hour. Over $7 million worth of boiler deficiencies have been identified which, if corrected, could save an estimated 11 million gallons of No. 2 fuel oil. Three million of the 11 million gallons presently are being saved as a result of work already completed.

The tune-up program for correcting plant deficiencies includes two distinct phases. The first phase is to establish and attain a level of boiler performance that is consistent with clean, efficient operation. To establish this baseline, NAVFAC EFDs will conduct a series of inspections and tests on each unit. The work will culminate in the calibration of automatic combustion controls to maintain combustion at the most efficient air-to-fuel ratios over the entire load range. The appropriate EFD has the additional responsibility of summarizing the necessary maintenance deficiencies and resource requirements for the activity so that funds can be made available for repair or improvement projects resulting from the inspections. The second phase of work involves source emissions testing (stack gas analysis), the results of which will be used in determining requirements for pollution abatement equipment.

An additional benefit of these boiler improvements is the on-the-job training and

experience that the facilities plant personnel will receive as they work on a day-to-day basis with manufacturers' representatives, architects, engineering contractors, and field division engineers and technicians. This will improve substantially the reliability of utility systems and should ensure that the conservation benefits obtained at the time of equipment adjustment are maintained.

Family Housing

Family housing uses about 10 percent of all energy consumed by the entire naval shore facilities. However, these energy costs account for about 25 percent of the total family housing O&M budget.

	Number of Units FY 1978	Cost/Unit Year FY 1978	Total Cost (Millions of dollars) FY 1978
Navy	74,901	$854	63.9
Marine Corps	21,012	780	16.4
Total	95,913	$838	80.3

FY 1978 utility costs for the Navy's housing were about 20 percent higher than FY 1975 costs. Family housing utility costs by percentage for FY 1975 through 1978 were:

	FY 1975	FY 1976	FY 1977	FY 1978
Electricity	66.1	67.4	65.4	63.0
Gas	13.7	14.2	15.7	17.4
Fuel Oil	9.9	7.4	7.8	6.3
Other	10.3	11.0	11.1	13.3
Total	100.0	100.0	100.0	100.0

The Navy's goal for housing conservation is to achieve a minimum 20 percent reduction in utilities consumption by FY 1985 when compared to the 1975 baseline year. However, the Navy will not impose on its housing occupants more stringent or restrictive energy conservation measures than those imposed in the private community. NAVFAC is responsible for implementing and monitoring the housing energy conservation programs.

Navy housing conservation programs are divided into three general categories: personnel, technical, and management. Personnel programs include public affairs and education programs that encourage housing occupants to participate in conservation programs, such as the annual Navy Department Energy Awareness Week, and stress energy conservation in all activity and housing publications.

The technical programs focus on:

- Installing storm windows, storm doors, solar screens, temperature setback thermostats, direct spark igniters, and insulation; replacing incandescent lighting with fluorescent; and applying new techniques as they become available.
- Demonstrating solar energy use in family housing domestic hot water, heating, and cooling systems.

- Developing new types of housing, such as the mesoquad design (earth covered), to minimize energy consumption in family housing.

The management program uses utility conservation teams to make comprehensive energy conservation surveys of activities. These teams look for routine repairs and other items that contribute to energy conservation. The recommendations may include repairing steam and other leaks, adjusting boilers, closing off unused areas, and installing thermostatically controlled dampers in individual rooms.

Family Housing Utility Metering

A GAO report estimated energy consumption in military housing as being significantly higher than for civilian housing. Congress, therefore, directed the Secretary of Defense to conduct a test program to include installing individual meters, establishing reasonable energy consumption ceilings (norms), and developing an automated system to issue bills for energy consumed above the norms. The 1978 MILCON Authorization Act provided for the metering of FY 1978 and subsequent new construction units. It also authorized $70 million to install meters in the existing DOD inventory in the 50 states, District of Columbia, Puerto Rico, and Guam. These funds, however, will not be released until Congress reviews the test results and decides to fully implement the program.

Congress specified five guidelines for the test as follows:

- Cost for purchasing and installing the meters and conducting the test is limited to a $8.5 million.
- At least 10,000 units must be sampled that provide a cross section of the various climatic zones.
- The test should include some units with and without storm windows, insulation, and other energy-saving devices.
- Occupants should receive a bill for excess consumption (which they do not have to pay during the test).
- Congress must be kept informed with scheduled progress reports.

The 10 activities selected by OSD for test include:

Zone	Location	Units	Service
Cold	Great Lakes, Illinois	2,089	Navy
Moderate	Port Hueneme, California	215	Navy
(without air conditioning)	Point Mugu, California	883	Navy
Moderate	Quantico, Virginia	1,109	Marine Corps
(with air conditioning)	Fort Eustis, Virginia	1,325	Army
Hot	Fort Gordon, Georgia	599	Army
Humid	Beaufort, South Carolina	1,276	Marine Corps
	Little Rock, Arkansas	1,535	Air Force
Hot	Cannon, New Mexico	1,012	Air Force
Dry	Yuma, Arizona	290	Army
	Total Units	10,333	

OSD also has established milestones for the metering program. Not later than 30 June 1978, meters for electricity, gas, oil, propane, steam, and hot water heat should have been installed in each military owned housing unit. The norm computation program and billing system began operating on 1 October 1978. Data problems were encountered for the first quarter of FY 1979 and the test has been extended through December 1979 to provide data collected for a full year. Two months have been set aside for analysis of test data and the results will be submitted to Congress by March 1980.

The Navy has developed a service-wide integrated billing system which will be used during the test. All locations have a remote terminal to transmit data to a central computer for processing. The system reports and bills will be printed over the remote terminal for local review and distribution.

Planning, Engineering, and Designing New Facilities

The objective of this program is to integrate energy policy, standards, and goals into the master planning, engineering, and design activities of NAVFAC and the EFDs. The MILCON plans and specifications for the Navy, Marine Corps, Army, Air Force, and defense agencies are prepared according to DOD standards and criteria. These standards and criteria include certain mandatory features relating to energy conservation, such as minimum insulation requirements, maximum ventilation rates, etc. In addition, other energy features which are project and site dependent are analyzed for each building construction project. For major building projects a computer energy analysis is required that simulates and projects the energy consumption of the various system alternatives being considered. The cost effective energy conservation features identified by these analyses are also included in the projects.

Specific and representative energy-related criteria in facilities planning, design and engineering which have been issued include:

- "Technical Guidelines for Energy Conservation."
- "Selection, Applications, and Cost Analysis of Control Building Automation Systems."
- "Criteria for More Economic and Better Insulated Underground Heat Distribution Systems."
- "Energy Conservation in New and Rehabilitated Buildings by Computer Simulation of Building Energy Consuming Systems."
- "Energy Conservation Lighting Criteria."
- "Mechanical Guide Specifications and Referenced Equipment Specifications for Better Energy Utilization."
- "Boiler Construction Criteria—Improved Design and Efficiency."
- Modernization of specifications for central steam heating plants.
- New specifications for convertible (coal-oil-gas) packaged boilers.
- Revised shore activity master plans to incorporate energy features, utilities planning, and total energy concepts.

- Revised guidelines for economic analyses of facilities projects.
- Specifications for EMCS.

NAVFACINST 4100.5A, Design Criteria Guidance for Energy Conservation, provides an updated and consolidated list of energy conservation measures to be considered in designing new buildings to achieve the required 45 percent reduction in energy use by 1985 as compared to similar buildings designed or constructed before 1975.

The instruction includes criteria for:

- Architectural—siting, building orientation, and envelope.
- Mechanical—HVAC system design, HVAC equipment selection, controls, and plumbing.
- Electrical—transformers, power factor, lighting, and distribution.

Energy conservation has been included as a requirement in NAVFAC's master planning function. All new plans and revisions of existing master plans must contain a separate analysis of energy planning considerations.

NAVFAC's design criteria is continually reviewed and revised as required to assure the application of newly developed materials, equipment, and systems that will reduce building energy requirements.

Vehicle Fuel Conservation

The Navy Department's goals regarding vehicle fuel consumption require the acquisition of more fuel-efficient vehicles and reduction of fuel consumption. A program that follows DOD guidelines for conservation of vehicle motor fuels has been promulgated by NAVFAC letter 1032 A/JVS of 17 April 1978 (OPNAV Notice 11240) and MCO 4100.4. The program calls for:

- Acquisition of more energy-efficient vehicles.
- Reduction of vehicle usage to a minimum.
- Maintenance of vehicles for optimum performance.
- Operation of vehicles in a fuel-efficient manner.

Procurement of new vehicles, commencing in FY 1978, is governed by Executive Order and new vehicles must meet specified average miles-per-gallon standards:

Year	Fuel Economy Standard[a] (miles per gallon)
1978	20
1979	22
1980	24
1981	26
1982	28
1983	30
1984	31
1985	31.5

[a]Reference Section 502 of the Motor Vehicle Information and Cost Savings Act (89 STAT 902, SUSC 2002) as implemented by Secretary of Transportation Regulation 42F.R. 33533, 33552, 30 June 1977, and as modified by Executive Order 12003, 20 July 1977.

Energy Measurement Project

Instrumentation to measure electricity and steam consumption is being installed at Sewell's Point Naval Complex, Norfolk, Virginia, for the Navy's first full scale measurements of energy consumption of buildings and piers. CEL is installing a battery of 16 microwave receivers on the roof of a new eight-story Bachelor Officers Quarters (BOQ). Signals will emanate from 16 remote locations throughout the complex. They will transmit data collected by sensors measuring kilowatts of electrical energy consumption, current and voltage in some cases, and Btus per hour of delivered steam.

The data will come from 19 selected facilities (14 buildings and 5 piers), such as the BOQ, dispensary, administration offices, heating and power plants, and supply buildings. Major instrumentation includes meters that automatically read existing electric and steam devices, clamp-on watt/watt hour meters, steam flow meters, temperature probes, meteorological sensors, microwave transmitters and receivers, and microprocessor controlled dataloggers.

In addition to obtaining frequent measurements of energy usage and demand, the project has three other specific objectives, including:

- To design, develop, and test a measurement and data acquisition system that determines cost effectiveness, accuracy, and reliability of utilities.
- To demonstrate new methods of measurement for use of EFDs, public work centers, and shore activities.
- To develop and test remote data acquisition methods and equipment.

Data obtained from the project will provide accurate and supportable inputs for planning and optimization/feasibility studies. A sound basis for economic analyses of energy alternatives will be provided. Project information also can be of significant benefit to public works utility operations. Of particular interest is the development of criteria for design of energy management and control systems.

Energy Conservation Research and Development

The objective of the shore facilities energy conservation R&D program is to reduce the consumption and total energy cost of shore activities by evaluating and implementing new technologies, or applying new operational practices that will reduce energy consumption. This will be achieved by eliminating energy losses and utilizing new auxiliary power generating, heating, and cooling equipment that is more efficient.

NAVFAC is responsible for energy conservation R&D at naval shore facilities. The Energy Program Office at CEL is the lead laboratory for this effort.

The Navy is building a technology base, tailored to its needs, by assimilating advances made in the national energy program and by evaluating more efficient energy utilization and generating systems. NAVFAC then applies the technology, where appropriate, to shore-based facilities. NAVFAC also is identifying and developing methods for eliminating wasteful usage in Navy facilities, such as the installation of storm windows and doors, insulation, and other simple retrofit modifications.

More sophisticated methods of conserving energy at shore-based facilities are being studied. These include improved construction materials, methods, and designs; improved or advanced HVAC systems; improved lighting systems and single building control systems; energy loss detection and measurement; energy applications analyses; and data compilation for on-site measurement of energy consumption.

A specially-constructed test bed at CEL, the Advanced Energy Utilization Test Bed (AEUTB), is being used to test new energy conservation and alternative energy source technologies. CEL is studying the detection and measurement of energy losses from buildings and pipelines by infrared and sulfur hexafluoride (SF_6) tracer gas techniques; procuring and assembling instrumentation packages to detect energy losses and for field survey use; and pursuing the use of video-taping. CEL is continuing the application of engineering studies to provide technology transfer from CEL to NAVFAC and the EFDs. A mobile laboratory assembled by CEL for on-site measurement of energy consumption is also being utilized in the field.

To increase building thermal efficiencies, alternative ways to save energy are being investigated on low-energy structure concepts for new construction and retrofit applications.

EMCS work, including effectiveness validation, study of expansion capabilities, determination of necessary evaluation criteria, study of advanced EMCS, and analysis of system economics, is being pursued. Installation of a retrofit system is also being undertaken at the Long Beach Naval Hospital.

Synthetic Fuels

The synthetic fuel program is designed to develop a capability to utilize fuels derived wholly or in part from domestically produced synthetic crudes in existing Navy hard-

ware by the mid-1980s. Major hardware changes are assumed to be impractical before this time. Immediate emphasis is placed on synthetic fuels that are now becoming available as a result of national R&D programs. The Navy's approach is to ensure that the Navy is an informed customer and able to use the products of the national synthetic fuel program.

The planned synthetic fuels testing program for facilities during the period FY 1979 through FY 1985 will include:

- *Fuel properties analyses.* Verification of chemical and physical properties and comparison with existing specifications; evaluation of effects of fuel property changes on equipment behavior.
- *Safety.* Evaluation of safety aspects compared with fuels in current use.
- *Component evaluation.* Possible minor equipment modification to ensure operability of in-service systems with synthetic fuels.
- *Small-scale boiler tests.* Small-scale testing to determine burner performance.
- *Fuel systems component testing.* Testing of compatibility and operability of fuel handling auxiliaries.
- *Full-scale operational boiler tests.* Full-scale testing to determine performance, including pollution effects and their control.

Boiler facilities for test of synthetic fuels and waste oil blends are located at CEL. The CEL boiler test facilities consist of two open air burners, one 200 HP water tube and one 30 HP boiler. These boilers are fully equipped with stack emission and performance measuring instrumentation. Systematic tests and evaluation of various synthetic fuels and waste oil blends are being conducted as they become available to determine fuel properties; fuel handling, preparation, and safety techniques; necessary modifications to boiler and fuel supply systems; long-term operating and maintenance considerations; and operating procedures for maximum boiler efficiency consistent with reduced pollutant emissions.

Alternative Energy Sources

Achieving the maximum measure of energy self-sufficiency for shore installations will be accomplished by using renewable energy sources and converting to more abundant fuels, such as coal. CEL, the principal activity performing R&D in alternative energy sources, and the Naval Weapons Center (NWC) are responsible for developing geothermal, solar, and wind energy conversion systems, waste-recovery techniques for producing energy, coal utilization technology applications, and data analysis studies and demonstrations. The current Navy goal is to achieve an 11 percent substitution of shore energy usage with power derived from alternative energy sources by 1985.

Coal Conversion/Reconversion

One of the methods to reduce consumption of petroleum products is to burn coal in plants in which the equipment is capable of reconversion. Major factors limiting reconversion are the need to install new grates and coal handling equipment, the need to locate coal supplies, and the necessity to meet current pollution abatement requirements. Also, most

installations need extensive feasibility studies, similar to one recently completed at the Public Works Center, Great Lakes, to determine the economics of the relatively high-cost conversions and subsequent O&M costs. To date, eight studies have been completed.

Geothermal Energy

Utilization of geothermal energy potential, located at a number of Navy sites, is being investigated for space heating and power generation. For example, it is estimated that at NWC, China Lake, as much as 4,000 MW of electric power could be generated using geothermal steam. The Navy has the authority to develop about 10 percent or 400 MW for its own use. This could satisfy the power requirements of all DOD activities in southern California. Other sites with geothermal energy potential are located at Adak, Alaska; Oahu, Hawaii; Fallon, Nevada; Keflavik, Iceland; and Norfolk, Virginia. The Navy intends to encourage the development of these sites and others as they become known, to provide low-cost energy.

Several naval bases are located on or near economically promising geothermal resources that could provide electric power or space heating. The Coso thermal area at the NWC, China Lake, and a resource at Adak, Alaska, are areas of potential major development.

Geological/geophysical studies by U.S. Geological Survey (USGS) and other agencies are continuing at Coso. NWC will continue to monitor activities in the area and assemble data needed for Navy evaluation of the area.

At Adak, following extensive geophysical studies conducted by USGS, three holes were drilled; drilling of the first hole was terminated due to hole squeeze, but the hole was completed with a steel liner to enable measurement of heat flow. The second hole was drilled to 628 meters; the temperature recorded at 549 meters was 49 °C. This hole was also completed with a steel liner, and temperatures are being monitored. The third hole has been abandoned.

Refuse-Derived Fuel

The Navy is also interested in implementing new methods of using refuse-derived fuel (RDF). One promising method has been demonstrated by this country's first waterwall trash-to-steam plant located at the Norfolk Naval Base. Since 1967 this plant has been producing steam from the pier area of the base. In addition, two RDF plants at NS Mayport and NAS Jacksonville will be operational in FY 1979 and a similar plant has been started at NSY Norfolk. Surveys now are being conducted to evaluate various other naval locations for either conversion to, or new construction of, RDF plants.

Solar Energy Initiatives

The potential for the application of solar energy for supplemental domestic hot water heating and space conditioning exists for many family housing units. Solar energy systems have been applied or are scheduled to be applied to family housing units at several locations.

The most notable of these retrofits is the application of solar domestic hot water systems for 385 units of family housing at Roosevelt Roads, Puerto Rico. In addition, DOE demonstration funds will be used to install solar energy systems for 16 units at Annapolis, Maryland, 12 units at New Orleans, Louisiana, and 20 units at Newport, Rhode Island. In compliance with the new Congressional solar goals, all new family housing units in the FY 1979 and subsequent program years are being analyzed for the application of solar energy.

In nonhousing areas, solar energy retrofit applications have and will be accomplished through ECIP, the EEP, and local funding actions. Since FY 1975, many new buildings have been studied and some have been selected for the application of solar energy. In compliance with the new Congressional solar goal that 25 percent of the MILCON Program will contain solar energy systems, all new buildings will be analyzed during design for the application of solar energy. In addition, many of the new buildings that have been under design are being reevaluated for the application of solar energy.

Progress is also being made in the areas of the application of passive solar energy and photovoltaics. The application of passive solar energy is one of many techniques being applied to new construction design to meet the Executive Order 12003 goal of 45 percent less energy consumption when compared to 1975 design standards. In addition, the most cost effective naval photovoltaic projects have been identified and submitted to DOE for funding consideration.

Other Alternative Energy Source Research and Development

In its alternative energy source R&D effort, begun in FY 1973, the Navy is developing the capability to use local, renewable energy sources at both remote and domestic bases. The Navy is also developing the capability to replace petroleum products at domestic bases with more abundant fuels, such as coal. The present R&D program includes:

- A three-phase study to determine the best way to convert from petroleum products to coal for electric power and steam generation systems at Navy bases.
- Study of the utilization of waste materials, primarily focusing on two areas: evaluation of packaged heat-recovery incinerators, and handling and burning tests of refuse-derived fuel.
- Siting and management support for a DOE funded fluidized-bed boiler demonstration at Great Lakes, with construction starting early in FY 1979.
- Testing and evaluation of various solar collectors by CEL to verify manufacturers claims.
- Studies on the conversion of wind energy to electricity and its potential use at various Navy installations.
- Studies to assess the potential of geothermal resources at Navy bases.

NAVY ENERGY CONSERVATION SHOWCASE

The Navy, under the DOD and DOE joint initiatives program, is planning to study energy conservation initiatives at Sewell's Point Naval Complex, Norfolk, Virginia. The objective is to technically demonstrate selected systems of energy savings and energy efficient devices which will give high visibility to integrated energy technologies, stimulate energy conservation, and encourage energy resource management. Eight innovative systems will be evaluated to determine the technical and economic parameters, the design, construction, operation and maintenance cost, forecast system reliability, and the operation and maintenance personnel requirements. The initiatives to be included in the energy demonstration showcase are:

- Coal gasification/cogeneration of electricity and steam with a gas turbine combined cycle power plant.
- Heat pump/ground water heat sink for heating and cooling houses using water-to-water and water-to-air heat pumps.
- EMCS simulation to optimize energy control strategies.
- Microprocessor optimization to test various types of energy controllers by building function.
- Solar boiler water preheater for boiler feedwater in a salvage fuel (incinerator) plant.
- Solar supplemental energy source to augment HVAC systems in a building.
- Community annual storage energy system to store energy for seasonal heating and cooling.
- Hot gas recovery by reclaiming heat wasted from refrigeration and air conditioning systems.

Evaluation studies will be conducted by the Navy and financed by DOE.

SHIP OPERATIONS

Ship operations energy programs provide the methodology and improved technology necessary to maintain the required levels of mission responsiveness and readiness in the face of decreasing energy supplies and rapidly increasing energy costs. In addition to enhancing energy conservation, ship programs are directed toward the use of synthetic fuels or modified fuel specifications to achieve greater fuel flexibility in fleet operations.

Energy Conservation

The Naval Sea Systems Command (NAVSEA) program includes existing and future fleet energy conservation. Considerable emphasis has been placed on hull maintenance to include underwater hull and propeller cleaning and the use of organometallic polymer (OMP) hull coatings and high-performance polymers that remain fouling-free while maintaining structural integrity on the surface of sonar domes, intakes, and propellers.

About 6 percent of a ship's fuel can be saved by periodic hull cleaning to remove marine fouling. If the ship can be cleaned while waterborne, significant dollar savings over dry-docking costs are achieved and fleet readiness is enhanced. By 1980, annual payback for hull cleaning alone could be $15 million in 1978 dollars. Fleet ships require cleaning every 3 to 9 months, but as the Navy develops advanced antifouling coatings, such as OMP paints, ships will require cleaning less often. By 1984, OMP paints should provide a five-year antifouling life, permitting hull cleaning only at times of major overhaul. Figure 15 illustrates the effectiveness of a hull maintenance program. The top line shows the typical curve for fouling, where after 300 days out of dry dock shaft horsepower requirements have increased by 20 percent from 4,000 to 4,800. Cyclical hull cleaning, the interim solution, results in the sawtooth curve with the related savings. The ultimate solution of no fouling is indicated by a horizontal line.

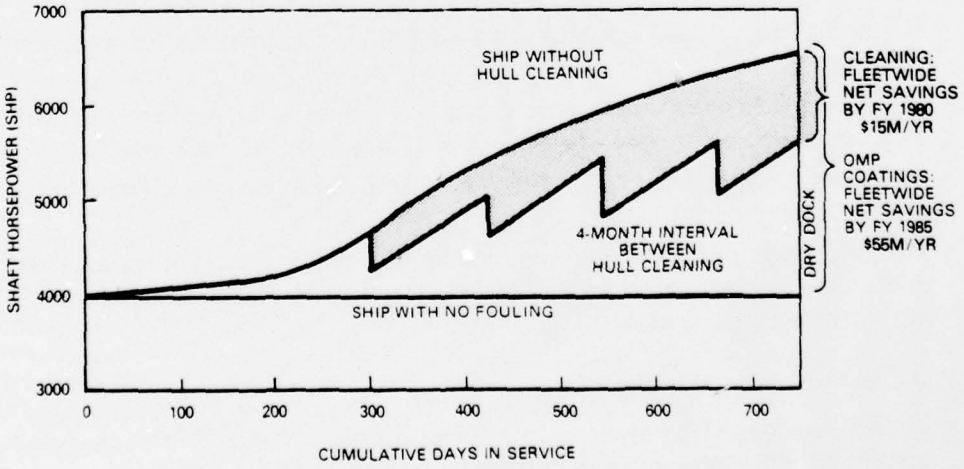


Figure 15. FUEL SAVINGS DUE TO HULL CLEANING/OMP COATINGS

Underwater Hull Cleaning

During FY 1978, the David W. Taylor Naval Ship R&D Center in Annapolis (DTNSRDC/A) completed all but one of four full-scale underwater hull cleaning trials. These trials consisted of extended tests of the fouling rates and loss of efficiency for the USS Stein (FF 1065) and USS Whipple (FF 1062) in the Pacific, and the USS Blakely (FF 1072) and USS Trippe (FF 1075) in the Atlantic. It was determined that shaft horsepower per ton displacement to maintain 140 RPM without hull cleaning increased at a rate of 1.85 percent per month in the Pacific and 0.44 percent per month in the Atlantic.

It also was determined that propeller fouling can cause a significant loss of efficiency. The percent decrease in the required power resulting from propeller cleaning is shown below for the three ships on which tests have been completed.

	At 140 RPM	At 16 knots
USS Whipple	14.8%	29.5%
USS Holt	5.4%	10.3%
USS Stein	7.7%	11.1%

These tests also demonstrated that the fuel penalty per ship is directly dependent on the thoroughness with which the hull and appendages are cleaned. Where the cleaning efficiency is considered to be 100 percent, the refouling rate is only 50 percent of that experienced where the cleaning efficiency is only 75 percent.

DTNSRDC/A initiated a project to design an appendage cleaning system and began studies on paint wear and refouling. DTNSRDC/A also initiated development of a dock block coating technique to provide protection for the normally unpainted hull areas. The Navy is accelerating the underwater hull cleaning program to take advantage of the significant fuel savings expected to accrue from such action. Accordingly, the following actions have been assigned to the fleet commanders:

- Beginning in FY 1979, funding is provided in the fleet budgets for underwater hull cleaning.
- A quarterly schedule, showing the ships to be cleaned and the dates for the respective cleanings, is to be provided to NAVSEA 15 days prior to each quarter.
- Sufficient funds will be provided to NAVSEA to clean all ships scheduled for cleaning in the upcoming quarter.
- Necessary base clearances and support will be provided to the contractor as required and contractor performance will be monitored as necessary to ensure compliance with contract specifications.

The Chief of Naval Material will:

- Provide, on a random basis, technical monitoring and checking of the contractual effort and effect prompt improvements to the program, as required to ensure maximum effectiveness.
- Provide instruction on hull cleaning for fleet guidance.

- Provide an OPNAVINST specifying NAVSEA and fleet responsibilities for the hull cleaning effort.
- Receive existing documentation and data from the fleets and contractor-generated documentation for analysis and publication of consolidated reports on accomplishments and problems.

Ship Simulators

The Navy has used ship simulators long before the present energy situation. The simulators range from large, cumbersome analog systems to sophisticated, digital computer-based systems, and are designed for specific purposes, such as shipboard antisubmarine warfare (ASW) and antiair warfare (AAW) training, pilot and navigation training, and surface ship warfare (SSW) tactical training and war gaming. Representative systems include: NEWS-WARS at Naval War College, Newport, Rhode Island; 20A61 at the Education and Training Center, Newport, Rhode Island; 14A2 ASW ship simulators at various locations; 14A6 ASW tactical trainers at Norfolk, Virginia, and San Diego, California; and TAC-DEW AAW trainers at Dam Neck, Virginia, and Point Loma, California. A 1,200 psi shipboard steam plant simulator, the 19E22 simulator, was completed at Newport, Rhode Island, during FY 1978. The cost of this simulator was about 15 percent of the cost to build a live 1,200 psi steam plant such as the one at Great Lakes. Operations and maintenance costs for the 19E22 are about 10 percent of the costs for a live plant. By training personnel on the 19E22, fuel savings are estimated at 50,000 barrels per year when full utilization is reached.

Ship Research and Development

Improved Hull Coatings

This project involves synthesis of OMP paints, which were applied for a patch-panel static immersion test and shipboard evaluation. Of the 150 OMP resins that were synthesized, four have shown antifouling characteristics through 5 years of patch-panel immersion tests.

Antifouling OMP hull coatings are undergoing tests for compliance with current military specifications. Small-batch formulations are being procured for patch-panel static immersion tests and shipboard application evaluation. The first test applications on ship hulls will take place during FY 1979.

Special application coatings designed for use on propellers and sonar domes are being developed by chemically altering commercially available and laboratory-synthesized polyurethane and epoxy resins to incorporate OMP antifoulants. Once synthesized into paints, the performance of these coatings will be laboratory-tested for compliance with current military paint specifications and also will be evaluated for antifouling effectiveness through patch-panel static immersion tests. If acceptable, sufficient paint quantities will then be procured to conduct shipboard evaluations. As these paints are introduced to the fleet, the need for the underwater hull cleaning program will be reduced.

DTNSRDC/A has completed screening the initial OMP paint formulations and has

selected two candidates for ship trials. During FY 1978 the trials plan was completed and a trials team assembled. A West Coast ship has been assigned to receive the first application in the early spring of 1979. DTNSRDC/A also continued to study those coatings that failed the early tests for possible second generation applications.

During FY 1978 over 20 plasma-sprayed high performance polymers were evaluated. Other special application coatings and elastomers were also investigated and the vulcanized bonding of antifouling rubber was evaluated for use as a propeller coating.

Machinery Optimization

The objective of the machinery optimization program is to reduce the fuel consumption of existing steam-powered ships by improving the operating procedures and machinery systems. Realistic energy utilization profiles will be determined for various missions, total steaming hours, the effects of degraded machinery conditions, and individual operator preferences. Based on these analyses, preliminary recommendations supported by cost information will be formulated for procedures and equipment modifications to effect energy savings. Based on a recent survey of FF 1052/1078 class frigates, it has been demonstrated that boiler modification and machinery alignment results in significant energy and cost savings. A significant result of the machinery optimization program is the conclusion that ship performance under different machinery and operational variables must be monitored continually.

Improved Hull and Appendage Design

The objective of this project is to identify existing designs and verify new designs of ship appendages, hulls, and propulsors that may reduce power loss or increase propulsive efficiencies. Candidate designs for naval ship hulls, appendages, and propulsors are being evaluated in laboratory model tests to identify those most likely to improve efficiency. A DD 963 class model was built with the stern section modified to fit naval stern appendages. Perry-class frigates also were evaluated to define improvements that might lead to new reduced-drag levels.

Machinery Performance Monitoring

The objective of performance monitoring is to provide ship engineering officers with diagnostic information on hull and power plant condition, thereby enabling immediate rectification of the effects of system malfunction/degradation and elimination of increased fuel consumption. NAVSEA will define the causes (such as design deficiencies, operator error, necessary maintenance, or system/component degradation) of nonoptimum operations aboard ship. From these determinations, performance monitoring is expected to provide an indication of deviation from optimum system heat balance, provide a quantitative basis for timely correction, promote a means for comparing different operating modes, and determine the effects of remedial actions.

During FY 1978 information on commercial machinery performance monitoring systems was collected and evaluated. A request for proposal was prepared for both a manual collection and an automatic collection and analysis system.

Combustion Optimizer

The fuel-to-air ratio of naval ships' boilers is presently set and maintained by an automatic combustion control (ACC) system which regulates excess combustion air in accordance with the boiler load. However, in order to maintain boiler combustion at peak efficiency over long periods of time, it is necessary to have a method for recalibration based upon continuous oxygen analysis. This recalibration method, which provides for continuous trimming of excess air, is intended to overcome the limitations inherent in the present ACC system.

Recent progress has included completion of vibration testing of both extractive and in-situ probes to establish design specifications. A contract has been awarded to Mine Safety Appliances for two prototype systems and a preliminary Test and Evaluation Master Plan has been prepared.

Low Excess Air Burners

The excess air levels required to effectively burn naval boiler fuels vary with boiler and burner design. The design excess air levels for 1,200 psi propulsion plants in use on naval ships range from 80 percent excess air at 10 percent boiler load to 15 percent excess air at full load. A reduction of these excess air levels to a maximum of 5 percent over most of the load range will result in higher boiler efficiencies and lower forced draft blower steam consumption. Currently designed burners cannot operate effectively at this low excess air criteria of 5 percent.

Recent progress includes completion of a market survey of available low excess air burners and procurement of test models of all candidate burners. The Naval Ship Engineering Center (NAVSEC), Philadelphia, will evaluate these burners in the Combustion Test Facility. Initially standard burners will be operated over their full ranges to obtain baseline combustion data for both mechanical and steam atomizers. NAVSEC will then test the candidate low excess air burners for comparison against this baseline data.

Improved Economizer

DTNSRDC/A is investigating methods of improving boiler efficiency by providing an additional stage of feed heating to more fully utilize the additional heat content of distillate fuels through modification of the existing economizer design.

This project was authorized in May 1978 and a contract for procurement of a prototype economizer unit has been awarded. The test agenda is being developed and installation plans are in progress.

Standby Main Feed Pump

Idling a standby main feed pump for emergency conditions requires 53,000 barrels of fuel per year for the FF 1052 class frigates alone. Electric motor and cold start steam turbines were investigated to replace one existing feed pump drive. The standby main feed

pump must have the capability of accelerating from a cold condition to rated capacity in sufficient time to protect the boilers in the event of a main feed pump failure.

A cold-start turbine retrofit has been determined to be cost effective and a contract has been awarded to Terry Corporation to provide a prototype unit equipped with a Worthington main feed pump, including a governor and controls.

Future Fleet Hull and Hull Appendages

The objective of the future fleet hull and hull appendages project is to minimize the fuel consumption attributable to the hull and hull appendage designs, over the total operational profile. Four white papers have been written and a scale model destroyer hull has been completed. Construction of models using transition stern and rudder concepts and development of energy-efficient hull design methodology has been initiated. Evaluation, through model testing, of a series of alternate propulsor types is under way.

Future Ships Propulsion Systems

DTNSRDC/A has initiated a project to identify and develop less energy-intensive ship propulsion system concepts. A diesel maintenance and reliability study and Phase I of a diesel propulsion noise analysis have been completed. Inclusion of continuous pitch control for controllable and reversible pitch propellers is being investigated (predicted fuel savings are 5 to 10 percent).

Future Ships Electrical Systems

An effort has been initiated to identify and develop alternative ship's service electrical system concepts that reduce energy consumption and life-cycle costs. Progress to date includes development of a quiet diesel (2,000 kW) generator acoustic package, and an Allison 501-K17 gas turbine efficiency improvement (part load) project which promises a 5 to 10 percent specific fuel consumption reduction. A contract was awarded to investigate the potential for ship service energy storage to achieve a 20 to 30 percent fuel reduction.

Future Ship Auxiliary Systems

Shipboard auxiliary systems include pumping, HVAC, lighting, and electric motors. Improved energy-conservative pumping system design practices have been developed by DTNSRDC/A and submitted to NAVSEC for review. Destroyer HVAC systems, the impact of heat pumps, suitability of Navy standard cooling coils for heating, and the use of waste heat air conditioning have been analyzed. DTNSRDC/A is testing a 2,000 kW quiet diesel generator suitable for installation aboard ASW combatants. Diesel engines used to drive electrical generators offer advantages in energy efficiency but noise isolation techniques are of concern. This program includes a comprehensive analysis to define in detail the various noise isolation options and their trade-offs.

A study of high intensity discharge lamps led to the preparation of a high-frequency solid-state ballast (HFSSB) specification, the preparation of a HFSSB test and evaluation

plan, and technical exchange of HFSSB data with DOE. DTNSRDC/A also completed a shipboard motors population and energy consumption study and awarded a contract for development of a high-efficiency (.97) 15 HP fire pump rotor.

Future Ship Total Energy Design

The objective of this effort is to ensure that maximum utilization of all sources of energy is incorporated into the ship design process. A computerized baseline Shipboard Total Energy Model (STEM-1) and a generalized steam turbine design model were developed and delivered to DTNSRDC. A contract to develop a waste heat boiler design routine was awarded in September 1978 and a component library development effort was initiated.

Fuel Oil Stripping

A new program has been initiated to determine how much usable fuel is lost because of shipboard fuel tank stripping and to recommend solutions to reclaim the fuel for shipboard use.

Synthetic Fuels

The synthetic fuels program for ship operations is designed to develop a capability to utilize fuels derived wholly or in part from domestically produced synthetic crudes in existing Navy ships by the mid-1980s. Major hardware changes are assumed to be impractical before this time.

It is highly unlikely that any single portion of a synthetic fuels industry, once commercially developed, would be solely dedicated to the supply of a single end-use customer. Like the present petroleum industry, the synthetic fuel industry will probably supply fuels across a broad spectrum of the consumer marketplace. It is within this marketplace that the Navy will probably obtain, as it has in the past, the fuels required to carry out its military missions.

Synthetic Fuels Testing

The planned synthetic fuels testing program for ships for FY 1980 through FY 1985 will include:

- *Fuel property analyses.* Verification of chemical and physical properties, comparison with existing specifications, and evaluation of the effects of various fuel properties on equipment performance.
- *Engine and component development.* Possible minor equipment modification and redesign to ensure operability of in-service systems with synthetic fuels.
- *Fuels comingling and additive development.* Evaluation of comingled fuels and investigation of additives to solve problems uncovered during engine testing.
- *Small-scale combustor tests.* Small-scale testing of six different boiler burner types, four or five different diesel combustor types, and three different gas turbine combustor types.

- *Fuel systems component tests.* Testing of compatibility and operability of fuel handling auxiliaries.
- *Full-scale land-based engine tests.* Full-scale testing of three different systems each for boilers, diesels, and gas turbines.
- *Sea trials.* Evaluation of synthetic fuels under at-sea conditions to determine performance handling and safety aspects of using synthetic fuels.

Fuels Flexibility

The fuels flexibility effort will ensure adequate sources of nonnuclear fuels during periods of reduced availability of specification fuels. As part of this effort, a study—"Alternative Petroleum Based Fuels for Naval Usage: Potential Availability, Cost and System Impact"—has been completed. In addition, a statement of work for developing an alternative fuels evaluation procedure has been drafted and statements of qualifications from interested bidders have been solicited.

Synfuels Toxicology

When using synthetic fuels, the nature and levels of airborne contaminants from fuels used in Navy ships must be determined to provide baseline data for assessing potential health hazards and recommending precautions. Atmospheric samples have been collected and analyzed from the USS Joseph Hewes (FF 1074), USS Talbot (FFG 4), USS Saratoga (CV 60), USS Elliott (DD 967), USS Manitowoc (LST 1180), and USS Caloosahatchee (AO 98).

Baseline data for diesel fuel marine (DFM) fuels also is being evaluated and dilution factors calculated for predicting the levels of synthetic fuels contaminants.

AIRCRAFT OPERATIONS

The Navy Department is achieving energy savings in aircraft operations by decreasing flying hours, using flight simulators, improving flight planning, and improving aircraft performance and efficiency.

Energy Conservation

Lead responsibility for aircraft energy conservation and improved fuel economy has been assigned to the Department of the Air Force under DOD RDT&E guidelines. However, Naval Material Command (NAVMAT) and Naval Air Systems Command (NAVAIR) have a program to use flight simulators, computerize flight planning, and undertake R&D programs to develop efficient configuration/component modifications for naval aircraft, and develop and implement more efficient operational procedures.

Aircraft Fuel Conservation Program

The objective of this program is to reduce fuel use of current and projected inventory Navy and Marine Corps aircraft without adversely affecting military effectiveness, pilot proficiency, and flight safety. A two-part approach is being used to achieve this objective: (1) identify changes that can be made to aircraft operations, tactics, and payload (equipment); and (2) identify cost acceptable physical changes or modifications to the aircraft that current/new technologies offer for improved fuel efficiency.

A fuel use survey was conducted in early FY 1978 to determine a logical order for investigating the 36 different types of Navy and Marine Corps aircraft. This survey identified six Navy and Marine aircraft types out of the 36 different types as the principal aircraft fuel users: F-4, P-3, A-4, A-6, A-7, and F-14, in order of total fuel consumed. These six types consumed approximately 75 percent of Navy and Marine aircraft fuel. A review of inventory and naval aviation planning documents revealed that all of these aircraft types exist in sufficiently large numbers and will be in the inventory long enough (beyond 1985) to warrant investigations as to possible fuel-saving operational changes or physical modifications.

Since FY 1978 program funds could not support operational and technological investigations on the six primary fuel user aircraft types, aircraft investigations were initiated, including manufacturer-performed fuel-saving technology application studies on the F-4 and P-3 types, and Navy-performed operations studies for typical fighter (VF), attack (VA), patrol (VP), and antisubmarine (VS) types.

Due to procurement lead time requirements, the F-4 and P-3 Fuel-Saving Technology Application Studies were awarded late in FY 1978 to the aircraft manufacturers, McDonnell Aircraft Company and Lockheed-California Company. Each manufacturer is conducting a 4-month, 1 man-year analytical study to identify feasible modifications to the aircraft and determine associated consequences. These studies are three-phase efforts. During Phase I, the contractor is conducting a survey of fuel-saving technologies and compiling a modifications listing explaining possible modifications to the aircraft (F-4 or P-3) which

conceivably could result in fuel saving by 1985. During Phase II, the contractor is required to analytically determine whether or not each modification on the Phase I listing is physically feasible. During Phase III, the contractor is required to determine the impact of each physically feasible modification on:

- Aircraft dimensions and weight.
- Fuel usage during significant flight conditions.
- Aerodynamics, stability and control, handling qualities, and performance during significant flight conditions.
- Survivability, vulnerability, maintainability, and reliability.
- Development and modification costs and schedules.
- Facilities, manpower, and supply networks.
- Initial operating capability (IOC) date of modification on aircraft.

These determinations are best estimates and detailed investigations will be conducted at a later date under separate contracts for promising modifications. These studies will provide a listing of feasible fuel-saving modifications and associated consequences from which decisions can be made as to which modifications to pursue. To date, each manufacturer has completed Phase I and II and is in the process of finalizing Phase III.

Navy-performed operations studies commenced in January 1979. VP/VS (P-3/S-3) operations were examined, followed by VA/VF (A-6, A-7/F-4, F-14) operations toward the end of FY 1978. The VP community has been conscious of the need to conserve fuel and other scarce assets and has sponsored several studies to examine fuel management techniques. Some of the techniques the P-3 community can use to save fuel are:

- Taxi outbound on two in-board engines, weather permitting.
- Transit at optimum cruise altitudes and maximum range airspeeds consistent with 925 °C T.I.T. limitation (monitoring system required).
- Loiter on two or three engines 10 to 20 knots below loiter speed.
- Minimize overfueling.
- Use the transit Jetplan whenever possible.

In addition to the above procedure-oriented recommendations, the following recommendations can contribute to VP fuel savings:

- Develop a Jetplan for VP training and operational flights (fuel planning).
- Develop computerized fuel management, environmental, tactical, and search decision aids for use at deployed sites (reduce wasteful flights).
- Develop a system to remove and store all unused external equipment (reduce drag).
- Develop the "Athena" deployable training simulator for P-3 crews (reduce training flights).

Techniques the VS (S-3) community can use to save fuel are:

- Fly near optimum cruise altitudes and maximum range airspeeds where time is not crucial (monitoring system required).

- Minimize overfueling.
- Remove and store unused external stores.

Additionally, the following developments are recommended:

- Develop a Jetplan for S-3 training and operational flights.
- Develop computerized fuel management and mission planning aids for use at deployed sites.
- Develop the "Athena" deployable training simulator for S-3 crews.

The VA (A-6, A-7) and VF (F-4, F-14) operational investigations commenced late in FY 1978 and are continuing in FY 1979. The principal finding of FY 1978 studies is that most VA/VF training flights are overfueled. Fuel management aids are to be developed for the VA/VF community to permit determination of fuel requirements for training flights.

Flight Simulators

Since 1975, the Navy has increased emphasis on training in a simulated environment in conjunction with training in operational equipment. The intent is to improve training effectiveness and maintain combat readiness while holding training costs to reasonable levels and coping with current and future problems of fuel availability. The Navy flight simulator training program is DOD directed, and includes funding for new devices and spare parts as well as for modifications of existing equipment to keep abreast of changes in aircraft systems.

DOD program efforts to achieve a 25 percent reduction in flying hours and a concomitant savings of energy resources by 1981 with increased use of simulators, has been consistently supported by Congress and the Navy. However, presently funded simulator programs will not achieve the 25 percent goal because of acquisition and support funding deficiencies, training effectiveness considerations, and manpower constraints. The Navy goal is to achieve a 9 percent substitution rate by 1985, but this rate actually will be achieved by 1982.

The Deputy Chief of Naval Operations (Air Warfare) and the Director of the Manpower and Training Division, in coordination with Marine Corps Headquarters, are responsible for all matters pertaining to the Navy's and Marine Corps' flight training devices. The Aviation Training Device Requirements Branch manages all simulator and other training programs and establishes requirements for flight training equipment, approves training device plans and programs, and prepares the simulator equipment budget that is considered by Congress.

The Navy uses several types of training devices, some of which simulate a wartime environment that could otherwise be produced only through the highly expensive deployment of carriers and aircraft. These devices include weapon system trainers, night carrier landing trainers, flight instrument trainers, air-combat maneuvering simulators, and initial F-18 training devices.

The anticipated annual fuel savings from the flight simulation program for the next 7 years are:

Fiscal Year	POL Gallons Saved (Millions per year)	Barrels (Thousands per year)
1979	78.0	1,900
1980	92.5	2,200
1981	95.0	2,260
1982-1985	96.0	2,285

Other benefits attributable to the use of simulators include an improved and increased training capability, a reduction in the number of aircraft accidents, extended airframe life, less use of airspace and airfields, and fewer missiles and less ammunition needed for training.

Computerized Flight Planning

The Navy is using a computerized flight planning service to optimize routing, altitude, airspeed, cruise management, fuel load, and payload trade-offs for point-to-point flights using current and forecast weather. Computerized flight planning (Jetplan) was used on about 20,000 flights in FY 1978 with a fuel savings of about 88,000 barrels and a cost savings of about $1.6 million. Jetplan was expanded to include Atlantic Fleet and Reserve P-3 aircraft, Reserve and Marine C-9 aircraft, and S-3A aircraft used for antisubmarine warfare missions.

In July 1979, the Optimum Path Aircraft Routing System, a Navy computer program designed to replace Jetplan, computer program will be complete and in-house evaluation will be started. The Naval Oceanographic Command will implement the Navy program, using weather stations as terminals and the Fleet Numerical Weather Central for computing services. By October 1979, six computer terminals will be installed at selected weather stations to provide a limited operational capability. Full operational capability will be reached sometime during 1980. In the interim, Jetplan will continue to be leased until the Navy program is fully operational to ensure uninterrupted availability of computerized flight planning capability.

Other Energy Conservation Research and Development

Aircraft energy conservation R&D is the responsibility of NAVAIR. The program activities include R&D tasks to improve the efficiency of aircraft propulsive systems and components, and studies and analyses to investigate aerodynamic configurations, air frame structures, and other aeronautical techniques applicable to aircraft design. The program also identifies ways to conserve fuel usage of current inventory Navy and Marine Corps aircraft. The goal of this latter program is to identify new (advanced) technology applications and modifications and/or mission operational alternatives which could save energy.

An additional task, to be initiated when funding is available, is to conduct fuel usage analyses of advanced weapon systems concepts and aid in the design of energy-efficient air systems as a function of both efficient aircraft design and new naval air operational concepts.

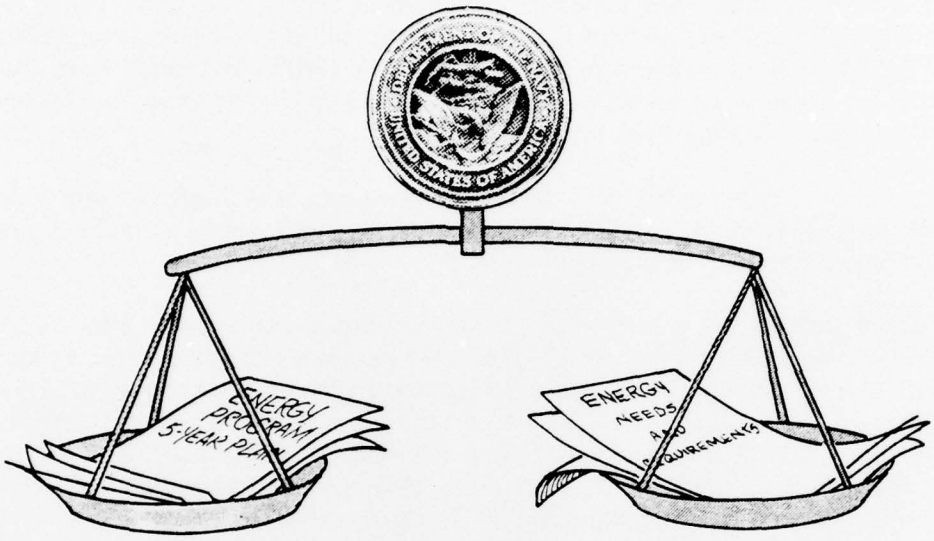
Synthetic Fuels

The synthetic fuel program for aircraft operations is designed to develop a capability to utilize fuels derived wholly or in part from synthetic crudes in existing Navy aircraft by the mid-1980s. Major aircraft hardware changes are assumed to be impractical before that time period.

The planned synthetic fuels testing program for aircraft from FY 1979 through FY 1985 will include:

- *Fuel property analyses.* Determination of fuel chemical and physical properties, comparison with existing specifications, and evaluation of effects of fuel property changes on equipment reliability.
- *Engine and component development.* Possible minor equipment modification and redesign to ensure operability of in-service systems with synthetic fuels.
- *Comingling of fuels and additive development.* Evaluation of comingled fuels and investigation of additives to solve problems uncovered during engine hardware component testing.
- *Small-scale combustor tests.* Small-scale testing of three different gas turbine combustor types.
- *Fuel system component tests.* Testing of compatibility and operability of fuel system components and fuel handling auxiliaries.
- *Full-scale land-based engine tests.* Full-scale engine testing of TF-30 and TF-34 engines.
- *Sea trials.* Evaluation of synthetic fuels in Navy aircraft under at-sea conditions, and handling and safety aspects of using synthetic fuels at sea.

Naval aircraft also will benefit from the fuels flexibility effort designed to ensure adequate sources of nonnuclear fuels during periods of reduced availability of military specification fuels (see Fuels Flexibility in Ship Operations).



DEPARTMENT OF THE NAVY ENERGY PLAN FOR FY 1979 THROUGH FY 1985

The Navy Department energy plan is the principal energy management and planning document used by the Navy Energy Office (OPNAV-413). It serves also to inform the Secretary of the Navy (SECNAV) and other interested offices within the Navy Department of program objectives, project descriptions, major milestones, and resource requirements.

Within this section, the many energy-related activities in which the Navy Department is engaged are organized as follows:

- Energy management
- Shore facilities
  - — Energy conservation
  - — Synthetic fuels
  - — Alternative energy sources
- Ship operations
  - — Energy conservation
  - — Synthetic fuels
- Aircraft operations
  - — Energy conservation
  - — Synthetic fuels

Individual descriptions for each project within these functional areas and strategies include a project description, milestones, Five Year Development Plan (FYDP) and required funding, responsible activities, and estimated energy savings at both the FYDP and required funding levels. The FYDP funding level program reflects the FY 1980 budget submission. The FYDP represents an allocation of resources within Navy priorities. The required funding level is the Navy Department's estimate for future years.

The Navy energy plan has been developed based on the best information available at the time. As new technology evolves and additional engineering surveys are conducted, the plan for future years will be modified.

Table 4 summarizes the Navy energy program funding requirements at the FYDP level. The FYDP level of $731 million for FY 1981-1985 should achieve annual energy savings of 47.58 trillion Btu beginning in FY 1985 at an estimated annual cost savings of $327 million in FY 1985 dollars. Also, as shown in Table 4, substitution will be achieved for 0.82 trillion Btu of petroleum valued at an annual cost of $5.6 million in FY 1985 dollars. Additional energy savings of 6.5 trillion Btu ($45 million in FY 1985 dollars) will be accomplished by changes in operational procedures and application of research, development, test and evaluation (RDT&E) programs. Additional substitution of 10.52 trillion Btu ($72 million in FY 1985 dollars) will be realized from solar, refuse-derived fuel, and coal substitution projects funded by the Department of Energy (DOE), new construction, and prior year money.

Table 5 summarizes the Navy energy program funding requirements at the required level. This level of $1,300 million for FY 1981-1985 should achieve annual energy savings of 64.05 trillion Btu beginning in FY 1985 at an estimated annual cost savings of $441 million in FY 1985 dollars. Substitution would be achieved for 10.26 trillion Btu of petroleum ($71 million in FY 1985 dollars). Additional energy savings expected from changes in operational procedures and RDT&E at this funding level would be 10.7 trillion Btu ($74 million in FY 1985 dollars). Additional substitution expected would be 13.65 trillion Btu ($94 million in FY 1985 dollars).

Table 6 summarizes the Marine Corps energy program funding requirements not included in Table 4. The separate Marine Corps funding level of $9 million should achieve annual energy savings of 0.14 trillion Btu beginning in FY 1985 at an estimated annual cost savings of $1.1 million in FY 1985 dollars.

AD-A074 834 TETRA TECH INC ARLINGTON VA F/G 5/1
DEPARTMENT OF THE NAVY ENERGY PROGRAM AND PLAN - 1979.(U)
AUG 79 N00014-78-C-0097
UNCLASSIFIED TETRAT-TT-A-6065-79-405 OPNAV-41P4.A NL

2 OF 3
AD
A074834

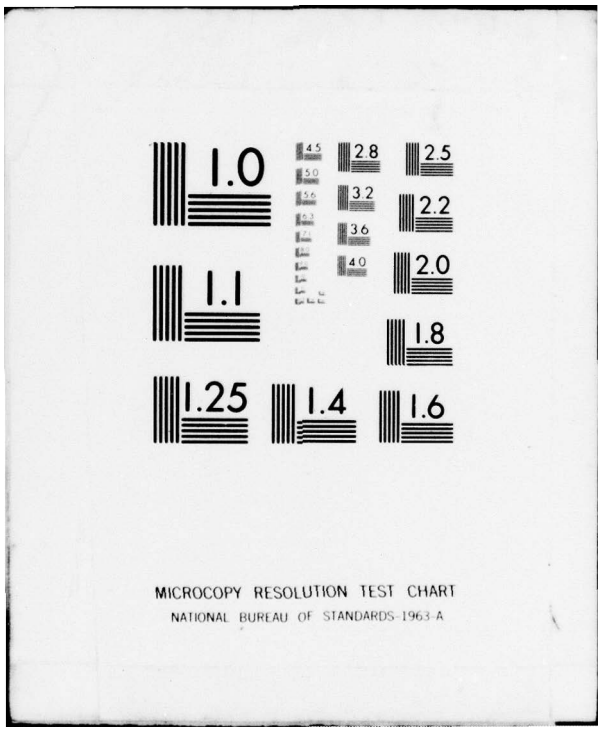

1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Table 4. NAVY ENERGY PROGRAM—FYDP FUNDING LEVEL

Appropriation/Project	Funding Requirement ($M)									FY 1985 Savings		Average Payback[b] (Years)
	FY 1975-FY 1978	FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	Total	Btu (10^{12})	$M[a] (1985)	
MILCON												
New buildings	—	—	—	—	—	—	—	—	—	2.53	17.4	c
Energy conservation investment program	107.4	42.9	46.7	53.0	55.0	50.0	60.0	60.0	475.0	20.38	140.2	3.4
Energy engineering program	—	—	—	—	—	—	—	—	—	—	—	—
Family housing	4.5	1.7	—	2.2	2.8	2.8	2.8	2.8	19.6	1.49	10.2	1.9
Reserve facilities	2.1	0.6	0.5	0.5	0.5	0.5	0.5	0.5	5.7	0.24	1.6	3.6
Substitution	—	—	16.2	11.8	—	—	—	—	28.0	0.82	5.6	4.2
Solar/P.L. 95-356	—	—	—	—	—	—	—	—	—	—	—	—
O&M												
Energy engineering program	—	7.7	8.3	8.7	9.2	9.7	10.3	10.9	64.8	3.50	24.1	2.7
Temperature setback/boiler tune-up	8.7	0.2	—	—	—	—	—	—	8.9	1.10	7.6	1.2
Hull maintenance	—	11.8	12.0	12.7	9.2	7.7	—	—	53.4	18.34	126.2	0.4
Stack gas analyzer	—	—	—	—	—	—	—	—	—	—	—	—
OPN												
Hull maintenance	—	—	—	1.2	2.4	1.2	—	—	4.8	d	d	e
Reduced flow shower heads	—	—	—	—	—	—	—	—	—	—	—	—
Stack gas analyzer	—	—	—	—	—	—	—	—	—	—	—	—
Energy conservation and management	—	—	—	—	—	—	—	—	—	—	—	—
WPN												
Energy conservation and management	—	—	—	—	—	—	—	—	—	—	—	—
APN												
Energy conservation and management	—	—	—	—	—	—	—	—	—	—	—	—
RDT&E												
Exploratory development	15.2	2.9	6.1	6.9	7.6	8.3	9.1	9.1	65.2	—	—	—
Advanced development (63724)												
Conservation (0829)	(3.1)	(2.3)	(5.1)	(7.6)	(9.3)	(10.0)	(10.5)	(10.5)	(58.4)	—	—	—
Synthetic fuels (0838)	(11.1)	(4.1)	(7.8)	(15.3)	(18.3)	(19.2)	(20.1)	(20.1)	(116.0)	—	—	—
Self-sufficiency (0840)	(1.8)	(2.0)	(4.3)	(8.2)	(10.5)	(11.2)	(11.8)	(11.8)	(61.6)	—	—	—
Total	16.0	8.4	17.2	31.2	38.1	40.4	42.4	42.4	236.1	—	—	—
Engineering Development (64710)												
Conservation (0371)	(7.2)	(4.0)	(6.9)	(10.9)	(13.1)	(13.9)	(14.7)	(14.7)	(85.4)	—	—	—
Synthetic fuels (0347)	—	—	(1.5)	(2.2)	(3.3)	(4.7)	(5.0)	(5.0)	(21.7)	—	—	—
Self-sufficiency (0350)	(1.5)	—	(0.6)	(1.5)	(2.3)	(2.7)	(2.8)	(2.8)	(14.2)	—	—	—
Total	8.7	4.0	9.0	14.6	18.7	21.3	22.5	22.5	121.3	—	—	—
Management and analytical support	4.0	1.2	1.3	1.3	1.3	1.4	1.5	1.6	13.6	—	—	—
Total: MILCON	114.0	45.2	63.4	67.5	58.3	53.3	63.3	63.3	528.3	—	—	—
O&M	8.7	19.7	20.3	21.4	18.4	17.4	10.3	10.9	127.1	—	—	—
OPN	—	—	—	1.2	2.4	1.2	—	—	4.8	—	—	—
WPN	—	—	—	—	—	—	—	—	—	—	—	—
APN	—	—	—	—	—	—	—	—	—	—	—	—
RDT&E	43.9	16.5	33.6	54.0	65.7	71.4	75.5	75.6	436.2	—	—	—
Total	166.6	81.4	117.3	144.1	144.8	143.3	149.1	149.8	1,096.4	—	—	—

[a]Estimated FY 1985 cost of $6.88 per million Btu (inflated at the rate of 6.4 percent per year).

[b]Average payback (years) calculated by dividing investment through FY 1984 by FY 1985 savings.

[c]*No investment required.*

[d]Included in O&M line.

[e]See O&M line.

Table 5. NAVY ENERGY PROGRAM—REQUIRED FUNDING LEVEL

Appropriation/Project	Funding Requirement ($M)									FY 1985 Savings		Average Payback[b] (Years)
	FY 1975-FY 1978	FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	Total	Btu (10^{12})	$M[a] (1985)	
MILCON												
New buildings	—	—	—	18.5	20.4	21.5	21.4	21.4	103.2	3.00	3.2[c]	32.2
Energy conservation investment program	107.4	42.9	46.7	53.0	55.0	50.0	60.0	60.0	475.0	20.38	140.2	3.4
Energy engineering program	—	—	—	—	17.0	102.0	76.0	50.0	245.0	9.60	66.1	3.7
Family housing	4.5	1.7	—	2.2	2.8	2.8	2.8	2.8	19.6	1.49	10.3	1.9
Reserve facilities	2.1	0.6	0.5	0.5	0.5	0.5	0.5	0.5	5.7	0.24	1.6	3.6
Substitution	—	—	16.2	15.3	22.1	8.5	—	—	62.1	8.42	57.9	1.1
Solar/P.L. 95-356	—	—	—	18.0	21.2	24.4	25.4	25.4	114.4	1.84	12.7	9.0
O&M												
Energy engineering program	—	7.7	8.3	11.2	11.9	12.6	13.3	14.1	79.1	3.50	24.1	3.0[d]
Temperature setback/boiler tune-up	8.7	0.2	—	—	—	—	—	—	8.9	1.10	7.6	1.2
Hull maintenance	—	11.8	12.0	12.7	12.7	12.7	8.0	5.3	75.2	18.34	126.2	0.6[e]
Stack gas analyzer	—	—	—	—	1.1	2.2	2.2	1.1	6.6	3.79	26.1	0.3
OPN												
Hull maintenance	—	—	—	1.2	2.4	1.2	—	—	4.8	[f]	[f]	[g]
Reduced flow shower heads	—	—	—	0.4	0.8	0.6	0.1	—	1.9	1.91	13.1	0.2
Stack gas analyzer	—	—	—	—	3.3	3.3	3.3	—	9.9	[f]	[f]	[g]
Energy conservation and management	—	—	—	—	1.5	1.5	1.5	1.5	6.0	0.24	1.6	3.8
WPN												
Energy conservation and management	—	—	—	1.5	1.5	1.5	1.5	1.5	7.5	0.30	2.1	3.6
APN												
Energy conservation and management	—	—	—	0.8	0.8	0.8	0.8	0.8	4.0	0.16	1.1	3.7
RDT&E												
Exploratory development	15.2	2.9	6.1	6.9	7.6	8.3	9.1	9.1	65.2	—	—	—
Advanced development (63724)												
Conservation (0829)	(3.1)	(2.3)	(5.1)	(7.6)	(9.3)	(10.0)	(10.5)	(10.5)	(58.4)	—	—	—
Synthetic fuels (0838)	(11.1)	(4.1)	(7.8)	(15.3)	(18.3)	(19.2)	(20.1)	(20.1)	(116.0)	—	—	—
Self-sufficiency (0840)	(1.8)	(2.0)	(4.3)	(8.2)	(10.5)	(11.2)	(11.8)	(11.8)	(61.6)	—	—	—
Total	16.0	8.4	17.2	31.2	38.1	40.4	42.4	42.4	236.1	—	—	—
Engineering Development (64710)												
Conservation (0371)	(7.2)	(4.0)	(6.9)	(10.9)	(13.1)	(13.9)	(14.7)	(14.7)	(85.4)	—	—	—
Synthetic fuels (0347)	—	—	(1.5)	(2.2)	(3.3)	(4.7)	(5.0)	(5.0)	(21.7)	—	—	—
Self-sufficiency (0350)	(1.5)	—	(0.6)	(1.5)	(2.3)	(2.7)	(2.8)	(2.8)	(14.2)	—	—	—
Total	8.7	4.0	9.0	14.6	18.7	21.3	22.5	22.5	121.3	—	—	—
Management and analytical support	4.0	1.2	1.3	1.3	1.3	1.4	1.5	1.6	13.6	—	—	—
Total: MILCON	114.0	45.2	63.4	107.5	139.0	209.7	186.1	160.1	1,025.0	—	—	—
O&M	8.7	19.7	20.3	23.9	25.7	27.5	23.5	20.5	169.8	—	—	—
OPN	—	—	—	1.6	8.0	6.6	4.9	1.5	22.6	—	—	—
WPN	—	—	—	1.5	1.5	1.5	1.5	1.5	7.5	—	—	—
APN	—	—	—	0.8	0.8	0.8	0.8	0.8	4.0	—	—	—
RDT&E	43.9	16.5	33.6	54.0	65.7	71.4	75.5	75.6	436.2	—	—	—
Total	166.6	81.4	117.3	189.3	240.7	317.5	292.3	260.0	1,665.1	—	—	—

[a]Estimated FY 1985 cost of $6.88 per million Btu (inflated at the rate of 6.4 percent per year).

[b]Average payback (years) calculated by dividing investment through FY 1984 by FY 1985 savings.

[c]Delta from FYDP = 3.00 − 2.53 = 0.47 Btu × 10^{12}.

[d]Delta due to additional O&M funds included in MILCON line.

[e]Additional funds are for hull cleaning in interim years.

[f]Included in O&M line.

[g]See O&M line.

Table 6. MARINE CORPS ENERGY PROGRAM—FYDP FUNDING LEVEL

Appropriation/Project	Funding Requirement ($M)								
	FY 1978	FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	Total
O&M, MC									
Utility engineering studies	0.2	–	–	0.5	0.5	0.5	–	–	1.7
Energy engineering program	–	–	–	0.5	0.5	0.5	0.5	0.5	2.5
Utilities metering	–	–	–	2.0	2.0	0.7	0.1	0.1	4.9

ENERGY MANAGEMENT

Under the direction of the Navy Energy Office, the Navy will continue to develop program plans and documentation in accordance with the Defense Planning, Programming, and Budgeting System (PPBS). Events scheduled to be completed in FY 1979 and FY 1980 include:

Publish SECNAV Instruction on Defense Contractor Energy Shortages and Conservation	OP-413/CMC	1/79
Update Navy Energy Briefing	OP-413	1/79
Conduct Energy Program Reviews on Facilities, Aircraft, and Ships	NAVFAC/NAVAIR/NAVSEA	2/79
Prepare FY 1978 Navy Energy Usage Analysis	OP-413/CMC	3/79
Publish Hull Cleaning Instruction	NAVSEA	3/79
Publish Department of the Navy Energy Management Annual Report for FY 1978-1979	OP-413	5/79
Develop Energy Cost Rates Through 2000	OP-413	5/79
Develop Program Objectives Memorandum-81	OP-413/CMC	5/79
Publish Synthetic Fuels RDT&E Program Plan	NAVMAT	7/79
Publish Department of the Navy Energy Program and Plan-1979	OP-413/CMC	7/79
Publish Guidelines for Energy Officers	OP-413/CMC	7/79
Revise DOD Acquisition Instructions 5000.1 and 5000.2	MAT-08T3/OP-413/Services	7/79
Present Energy Awards	CNO/CMC	7/79
Conduct Energy Awareness Week	CNO/CMC	10/79
Publish Navy Energy Research and Development Program Plan FY 1980 through 1985	NAVMAT	10/79
Redesign Navy Energy Usage Profile and Analysis System (NEUPAS) Program	NARDAC	9/80

Management Studies and Technical Support

Responsible Activity

O&M,N: OPNAV (OP-413)
RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

Various energy studies provide support to the energy management program to develop profiles of the energy characteristics of individual Navy bases, and Civil Engineering Laboratory (CEL) contracts for support to obtain and analyze and of Navy shore installation climatic environments, energy uses, and consumption. Data related to the application of new power systems and conservation measures at Navy shore installations are being assembled, analyzed, and indexed.

An additional study is being conducted to review Navy policy governing central steam and electric power generation in view of current fuel costs and projected escalation. The economics of central steam and power generation will be compared with dispersed steam generation and purchased electric power.

Other energy management contract support provided to the Navy Energy and Natural Resources R&D Office includes:

- Preparation of an integrated Navy Energy R&D Program Plan, incorporating consideration of technological advances already achieved, and a Navy Energy R&D Program Summary.

The Navy Energy Office uses contractual support to:

- Edit and publish an annual update to the Department of the Navy Energy Program and Plan and Energy Management Annual Report.
- Prepare guidance materials for use in conducting an annual Navy Department Energy Awareness Week.
- Prepare a technical engineering energy resource management manual for use by energy specialists throughout the Navy and Marine Corps.

SHORE OPERATIONS

In response to the need to conserve energy in the operation of its shore facilities and in accordance with Department of Defense (DOD) and national guidelines, the Navy has developed a comprehensive energy plan and program for shore operations. This program includes:

- Energy Conservation
  - — Exploratory Development
  - — Energy Conservation Investment Program (ECIP)
  - — Energy Conservation and Management (ECAM) Program
  - — Family Housing Energy Conservation
  - — Reserve Facilities Energy Conservation
  - — Energy Engineering Program (EEP)
    - Cogeneration/Total Energy Systems
    - Industrial Energy Retrofits
    - Energy Monitoring and Control System (EMCS)
    - Industrial/Boiler Water Treatment
    - Air Conditioning Tune-up
    - Heating and Cooling Operator and Mechanic Training
    - Energy Efficiency Indices
    - Energy Distribution System Improvements
    - Alternative Energy Sources
    - Heating and Power Plant Optimization
    - Energy Technology Applications Program (ETAP)
  - — *New Facilities Energy Conservation*
  - — Boiler Tune-up Program
  - — Temperature Setback Devices
- Synthetic Fuels
  - — Synthetic and Waste Fuels Combustion Research and Development
- Alternative Energy Sources
  - — Exploratory Development
  - — Coal Conversion/Reconversion
  - — Solar Energy Systems
  - — Geothermal Resource Development
  - — Refuse-Derived Fuel Systems
  - — Energy Self-Sufficiency Studies/Demonstration

Energy Conservation Exploratory Development

Responsible Activity

RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

The following technology goals define the specialized areas of development effort necessary to achieve the Navy Department energy conservation R&D program objectives:

- *Thermal Engineering of Buildings.* Develop and evaluate improved building component design and construction concepts for Navy buildings and utilize the latest analytical methods for predicting energy demand and performing cost trade-off studies.
- *Low Energy Structures.* Develop building designs that minimize heating and cooling loads, and predict resulting energy and cost benefits.
- *Advanced Heating, Ventilating, and Air Conditioning (HVAC) Systems.* Investigate more efficient and reliable HVAC systems for buildings.
- *Facilities Cogeneration.* Analyze electric and boiler cogeneration design criteria, modifications, and operations to improve thermal efficiency and reliability.
- *Electrical Systems.* Formulate engineering and maintenance methodology and develop improvements for systems that consume or transmit electrical energy.
- *Energy Monitoring and Control Systems.* Investigate the effectiveness of existing monitoring and control systems and recommend engineering guidance for the selection and development of advanced systems.

Energy Conservation Investment Program

Responsible Activity

MILCON: NAVFAC (FAC-111)

Description

FYDP Funding Level

The Energy Conservation Investment Program (ECIP) provides for improvements, alterations, upgrading, and repair of existing structures and utility systems to reduce unnecessary energy consumption. For FY 1979 and FY 1980 the program includes:

Project	FY 1979		FY 1980	
	Number of Projects	Cost (Millions of dollars)	Number of Projects	Cost (Millions of dollars)
Steam and condensate systems	2	1.4	9	17.2
Boiler plant modifications	4	3.6	1	0.9
Lighting systems	7	3.2	8	2.8
HVAC systems	8	4.6	1	0.1
Energy monitoring and control systems	15	19.7	5	7.4
Insulation and storm windows	7	2.5	9	5.4
Building alterations	9	6.0	10	11.6
Energy recovery systems	2	1.9	–	–
Solar energy	–	–	1	1.3
Total	54	42.9	44	46.7

Projects for FY 1981 through FY 1985 will be similar in nature and proposed work to be performed is now being evaluated.

Research and development efforts in support of the ECIP will focus on conservation in machinery, buildings, and energy systems.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

Btu $\times 10^{12}$	20.4
Barrels $\times 10^{3}$	3,517.0
$ Millions (1978 dollars)	60.1

Energy Conservation and Management Program

Responsible Activity

MILCON: NAVFAC (FAC-11)
O&M,N: NAVFAC (FAC-11)

Description

FYDP Funding Level

Funding for energy conservation and management (ECAM) projects for government-owned, contractor-operated (GOCO) plants is included in production base or industrial facility budgets (Program Element 780110). All budgets for ECAM projects must be supported by economic analyses consistent with the guidelines contained in the Office of Management and Budget Circular No. A-94 and DOD Instruction 7041.3.

Naval Facilities Engineering Command (NAVFAC) has initiated surveys at the Naval Industrial Reserve Ordnance Plant, Minneapolis, and Grumman Bethpage GOCO facilities as candidates for FY 1981 submissions. NAVFAC has programmed resources under the Energy Engineering Program (EEP) from FY 1979 for energy surveys of all remaining GOCOs. It is anticipated that projects resulting from the FY 1979 surveys will be submitted for programs in FY 1982 and later.

The FYDP includes funding for the surveys only. Implementation funds are included at the required funding level.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

There are no savings at this funding level.

Required Funding Level

Btu $\times 10^{12}$	0.7
Barrels $\times 10^{3}$	120.7
$ Millions (1978 dollars)	2.1

Family Housing Energy Conservation

Responsible Activity

MILCON: (FHMA,D) NAVFAC (FAC-08)

Description

FYDP Funding Level

Military construction (MILCON) (FHMA,D) projects planned for family housing include typical ECIP projects as previously described under the ECIP program. Housing projects are evaluated and approved using the same criteria as for all other ECIP projects.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

Btu $\times 10^{12}$	1.5
Barrels $\times 10^{3}$	260.0
$ Millions (1978 dollars)	4.4

Reserve Facilities Energy Conservation

Responsible Activity

MILCON: Chief of Naval Reserve/CMC

Description

FYDP Funding Level

Projects funded for Naval Reserve Facilities include typical ECIP projects as described under the ECIP program. The projects are evaluated and approved using the same criteria as for all other ECIP projects.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

Btu $\times 10^{12}$	0.2
Barrels $\times 10^{3}$	41.0
$ Millions (1978 dollars)	0.7

Cogeneration/Total Energy Systems

Responsible Activity

MILCON: NAVFAC (FAC-111)
O&M,N: NAVFAC (FAC-111)
RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

The Navy is the lead DOD service for cogeneration and will coordinate cogeneration RDT&E and interagency agreements. The Navy will develop and apply methodology to conduct base-wide and area-wide analyses for applying cogeneration and the total energy concept. Specific R&D advanced development objectives for FY 1979 are to identify the most probable high payback sites for feasibility studies; perform three comprehensive feasibility studies, up to the 30 percent design stage, that address all constraining variables; and evaluate localized spot cogeneration, heat recovery, and energy cascading opportunities.

FY 1979 R&D will continue to support this EEP element to ensure incorporation of state-of-the-art equipment and technology. Three Operations and Maintenance, Navy (O&M,N) supported feasibility studies will be conducted annually to determine the best applications and site selections beginning in FY 1980.

Required Funding Level

MILCON funding is required beginning in FY 1982 to begin construction, at those sites where cogeneration systems are deemed cost-effective, at a rate of one large and two small sites per year. The sites are selected through O&M,N supported studies conducted under the basic program.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

There are no savings at this funding level.

Required Funding Level

Btu $\times 10^{12}$	2.0
Barrels $\times 10^{3}$	345.0
$ Millions (1978 dollars)	5.9

Industrial Energy Retrofits

Responsible Activity

MILCON: NAVFAC (FAC-111)
O&M,N: NAVFAC (FAC-111)
OPN: NAVAIR, NAVSEA
RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

Significant reduction in the consumption of energy at Navy industrial facilities is expected as a result of this element of the EEP. Opportunities for energy conservation will be identified, specific projects with acceptable energy-cost ratios initiated, and a methodology to guide follow-on surveys developed. During FY 1979, comprehensive R&D funded pilot surveys initiated in FY 1978 will be finalized through contract at the Naval Shipyard in Philadelphia, Naval Air Rework Facility in Norfolk, Naval Industrial Reserve Ordnance Plant in Minneapolis, and the Naval Weapons Industrial Reserve Plant in Bethpage to determine the potential for industrial energy conservation and the most effective survey techniques for similar follow-on surveys. The latter two facilities are GOCO facilities.

At least four additional industrial surveys per year, two of which must be at GOCO plants, will be initiated in FY 1979. Modification which can be implemented immediately will be identified upon completion of the surveys. Also to be identified are the long range facilities retrofit actions requiring significant capital investment.

A formal ECAM program for GOCO plants has been established as the result of FY 1980 consolidated guidance. Funding for ECAM actions initiated by DOD components will be included in the plant's production base support or the industrial facility budgets. A comprehensive plan for the development of ECAM projects is to be implemented at each facility. Updating this plan at yearly intervals will ensure that appropriate projects are identified, budgeted for, and completed.

Required Funding Level

Major retrofits at industrial sites would begin in FY 1982 using MILCON, procurement, or RDT&E funds.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level		Required Funding Level	
Btu $\times 10^{12}$	0.5	Btu $\times 10^{12}$	4.2
Barrels $\times 10^{3}$	78.0	Barrels $\times 10^{3}$	728.0
$ Millions (1978 dollars)	1.3	$ Millions (1978 dollars)	12.4

Energy Monitoring and Control Systems

Responsible Activity

MILCON: NAVFAC (FAC-111)
O&M,N: NAVFAC (FAC-111)
RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

The Navy is the lead DOD service for Energy Monitoring and Control Systems (EMCS) RDT&E and, in addition to coordinating the R&D effort, will publish procedures for determining and applying the optimum EMCS for each activity. The FY 1979 objectives are to develop guidance and retrofit an existing EMCS with modern microprocessor techniques and hardware at a naval hospital (R&D initiative). In FY 1979 a public works center (PWC) EMCS and metering demonstration also will be conducted and 10 EMCS studies will be completed. Installation of improved EMCS systems at selected sites will begin in FY 1982 (funded by ECIP). In FY 1979 a report on recommended use and potential economic benefits of technology was issued. RDT&E efforts, in addition to the above demonstration projects, focus on evaluating and demonstrating a microprocessor timeclock, determining the capabilities of a modularized approach to EMCS expansion, and determining the economic and operational potential for high-technology modifications of installed EMCS. The use of government owned and furnished EMCS software will be investigated and support requirements for government-furnished equipment software maintenance will be developed. Local loop control alternatives will be evaluated and control algorithms for computerized control will be developed and tested. CEL also is deriving methods for evaluating the economics of proposed EMCS.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

Energy savings resulting from the EMCS program are reported under ECIP.

Industrial/Boiler Water Treatment

Responsible Activity

O&M,N: NAVFAC (FAC-111)

Description

FYDP Funding Level

The program will provide improved control procedures to minimize thermal losses of 3,500 Navy boilers. Implementing teams will inspect approximately 20 percent of the Navy boilers annually to recommend procedural changes and maintenance actions.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

Btu $\times 10^{12}$	0.4
Barrels $\times 10^{3}$	76.0
$ Millions (1978 dollars)	1.3

Air Conditioning Tune-up

Responsible Activity

MILCON: NAVFAC (FAC-111)
O&M,N: NAVFAC (FAC-111)

Description

FYDP Funding Level

The Navy has developed and implemented an Air Conditioning Tune-up program (ACT-UP) to improve the operation and maintenance of over 1,000 major air conditioning plants that have a capacity greater than 50 tons. Possible actions will be to replace inefficient and wasteful controls, add controls where there are none, and replace entire systems that may be inefficient. In FY 1978, the Navy demonstrated (RDT&E engineering development) a prototype tune-up under the ACT-UP program at Naval Air Station (NAS) Jacksonville, Florida, to detect, locate, and correct problems in Navy air conditioning systems. Initial results indicate a possible 30 percent reduction in air conditioning energy requirements. Engineering Field Division ACT-UP teams have been formed to conduct annual visits and tune up major air conditioning plants. In FY 1982, FY 1983, and FY 1984 MILCON (ECIP) will be required to provide new and more efficient air conditioning equipment to replace defective equipment identified by the ACT-UP teams.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

Btu $\times 10^{12}$	0.3
Barrels $\times 10^{3}$	45.0
$ Millions (1978 dollars)	0.8

Heating and Cooling Operator and Mechanic Training

Responsible Activity

O&M,N: NAVFAC (FAC-111)

Description

FYDP Funding Level

To provide utilities operators and maintenance personnel with effective and efficient operations and maintenance procedures and technology, the Navy is reviewing, updating, and initiating training courses. Other efforts include developing comprehensive support for career advancement of utilities personnel; conducting regional seminars periodically to interchange O&M techniques and update field division personnel on Navy energy management policy; providing a correspondence course for utility system operators to assist in energy conservation, especially as related to boiler plant, air conditioning, and EMCS operations; and updating and revising technical maintenance and operation manuals. Course development is expected to be completed in FY 1979. The resulting training program will be expanded to include new technologies.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

Btu $\times 10^{12}$	0.2
Barrels $\times 10^{3}$	40.0
$ Millions (1978 dollars)	0.7

Energy Efficiency Indices

Responsible Activity

O&M,N: NAVFAC (FAC-111)

Description

FYDP Funding Level

The Navy is identifying and developing utilities technical management indices to assist shipyards, PWCs, and other major Navy activities in improving their energy systems management. Management capability will be provided to effectively monitor indices to identify potential energy conservation actions as required.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

Btu $\times 10^{12}$	0.4
Barrels $\times 10^{3}$	60.0
$ Millions (1978 dollars)	1.0

Energy Distribution System Improvements

Responsible Activity

MILCON: NAVFAC (FAC-111)
RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

To improve energy distribution, both R&D and O&M projects are planned. Expertise will be provided to evaluate energy conservation potential, with surveys beginning in FY 1979. Utilities energy distribution systems improvements for shore facilities will be identified in the surveys. Navy R&D will provide continued support to the EEP to ensure continued improvements in equipment and technology.

Required Funding Level

The MILCON money necessary to modernize and retrofit the energy distribution systems identified by the surveys is included at this funding level.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

There are no savings at this funding level.

Required Funding Level

Btu $\times 10^{12}$	2.0
Barrels $\times 10^{3}$	360.0
$ Millions (1978 dollars)	6.2

Alternative Energy Sources

Responsible Activity

O&M,N: NAVFAC (FAC-111)

Description

FYDP Funding Level

The Navy will evaluate developing technology and methodology to identify possible renewable and nonfossil energy applications to conserve Navy nonrenewable energy resources. These applications will include nonfossil resources such as solar, wind, geothermal energy, and refuse-derived fuels. The program is more completely defined under alternative energy source projects (coal conversion, solar, geothermal, and refuse-derived fuels).

Required Funding Level

See alternative energy source projects.

Heating and Power Plant Optimization

Responsible Activity

MILCON: NAVFAC (FAC-111)
O&M,N: NAVFAC (FAC-111)

RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

The Navy will develop and implement a program to improve plant efficiency at Navy central steam and/or electric plants by upgrading burner equipment air mixture controls, correcting operational and maintenance deficiencies, and training personnel. Technical knowledge will be obtained for studies to be conducted at about 10 bases annually. Major retrofit actions will begin in FY 1982. R&D activities will be centered on providing assessments of available technology for specific site installations.

Required Funding Level

MILCON funding will be required beginning in FY 1982 to modernize both heating and power plants.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level		Required Funding Level	
Btu $\times 10^{12}$	0.4	Btu $\times 10^{12}$	2.1
Barrels $\times 10^{3}$	66.0	Barrels $\times 10^{3}$	366.0
$ Millions (1978 dollars)	1.1	$ Millions (1978 dollars)	6.3

Energy Technology Applications Program

Responsible Activity

O&M,N: NAVFAC (FAC-111)

Description

FYDP Funding Level

NAVFAC centrally manages an O&M,N funded program to identify, validate, and implement high dollar and energy payback projects which cannot be funded under current MILCON fund limits. The program is similar to the highly successful pollution abatement program.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

Btu $\times 10^{12}$	1.4
Barrels $\times 10^{3}$	240.0
$ Millions (1978 dollars)	4.1

New Facilities Energy Conservation

Responsible Activity

MILCON: NAVFAC (FAC-111)
RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

This program includes:

- Review of energy analyses for FY 1980 MILCON projects and future programs to determine compliance to the 45 percent energy reduction requirement.
- Computer energy studies to develop criteria on mounding/underground construction.
- Specifications for solar energy systems.
- Specifications and definitive drawings for solid waste heat recovery plants.
- Criteria for the design of interior lighting systems using an improved computer program.
- Updating existing design criteria/specifications to include new developments in energy efficient equipment and systems.

It is estimated that a 38 percent reduction in energy consumption can be realized without additional funding.

Required Funding Level

Additional funding will be requested as necessary to implement solar energy systems, waste heat recovery systems, etc., to meet the full Executive Order 12003 goal of 45 percent reduction.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level		Required Funding Level	
Btu $\times 10^{12}$	2.5	Btu $\times 10^{12}$	3.0
Barrels $\times 10^{3}$	436.0	Barrels $\times 10^{3}$	517.0
$ Millions (1978 dollars)	7.5	$ Millions (1978 dollars)	8.9

Boiler Tune-up Program

Responsible Activity

MILCON: NAVFAC (FAC-111)
O&M,N: NAVFAC (FAC-111)

Description

FYDP Funding Level

The objective of the Boiler Tune-up Program is to assure compliance with air emission regulatory standards and to achieve the optimum combustion and thermal efficiency. This program will be completed in late FY 1979.

Annual Energy Savings (Beginning in FY 1979)

FYDP Funding Level

Btu $\times 10^{12}$	0.4
Barrels $\times 10^{3}$	69.0
$ Millions (1978 dollars)	1.2

Temperature Setback Devices

Responsible Activity

MILCON: NAVFAC (FAC-111)
O&M,N: NAVFAC (FAC-111)

Description

FYDP Funding Level

The objective of the Temperature Setback Devices program is to assure the installation of an automatic control system on all natural gas heating systems. This program was completed in late FY 1978.

Annual Energy Savings (Beginning in FY 1978)

FYDP Funding Level

Btu $\times 10^{12}$	0.7
Barrels $\times 10^{3}$	34.0
$ Millions (1978 dollars)	2.1

Synthetic and Waste Fuels Combustion Research and Development

Responsible Activity

RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

Combustion techniques and devices suitable for use in typical Navy boilers are to be developed so that the use of synthetic fuels will be environmentally acceptable. Furthermore, ways are to be developed to increase the fraction of waste oil that can be burned in mixtures with clean fuel oils. Boiler performance should be maximized with consideration for the level of pollutant emissions related to boiler operation. Procedures and systems for handling and burning these fuels in Navy steam generators also are to be developed and the capability of Navy boilers is to be expanded to allow firing of a wide range of fuel oils.

CEL's boiler test facilities, consisting of two open-air burners (one 200 HP watertube and one 30 HP firetube boiler) equipped with stack emission and performance measurement instrumentation, will be used to obtain the experimental information necessary to burn synthetic fuels, such as shale oils, refuse-derived oils, coal liquids, coal oil slurries, biomass-derived fuels, and Ocean Thermal Energy Conversion derived fuels in Navy stationary boilers. These fuels will be tested and evaluated systematically to determine fuel properties; fuel handling, preparation, and safety techniques; necessary modification to boiler and fuel supply systems; multifuel capability requirements; long-term operating and maintenance considerations; pollutant emissions related to boiler operations; and operating procedures for maximum boiler efficiency consistent with reduced pollutant emissions. The fuel then will be burned in a boiler demonstration plant for final transition to routine Navy operations. (The boiler demonstration plant has been proposed for advanced development funding.)

New boiler hardware, procedures, and concepts for safety, emission controls, and efficiency improvement will be studied as they become available. This will include the test and evaluation of devices, such as emulsion fired burners, low nitrogen oxides burners, combustion and modification techniques, energy-saving devices, stack gas monitoring packages and boiler controls, and fuel additives. Operational boilers will be used for these evaluations to verify performance, modification procedures, and effects on maintenance requirements. The results will be formally documented in a technical memorandum at the conclusion of each experiment. Operational data should be available by 1984 and required funding level recommendations will be made on the suitability for Navy adaptation.

Major milestones include:

- FY 1979
  - — Participate in and provide technical support for Naval Weapons Center (NWC) waste fuels combustion tests. Determine how results can be applied Navy-wide.
  - — Evaluate high-efficiency burners with low emission of nitrogen oxides.

- Demonstrate burners on Navy boilers and make recommendations.

- FY 1980
  - Provide necessary documentation to NAVFAC to justify field implementation of burning waste/fresh fuel oil blends. Provide interim recommendation and documentation.
  - Prepare Waste Oil Combustion Handbook.
  - Identify high-efficiency low-emission burners for Navy applications.
  - Investigate advanced burner concepts to meet future Navy needs and prepare status reports.

Alternative Energy Sources Exploratory Development

Responsible Activity

RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

The following technology goals define the specialized areas of development necessary to achieve the Navy energy R&D program objectives for energy self-sufficiency.

- *Energy Storage and Advanced Concepts.* Develop advanced energy storage techniques and expand the Navy technology base in advanced, high performance energy conversion systems.
- *Coal Utilization.* Analyze and recommend power systems to utilize coal as an energy source for naval facilities.
- *Energy from Solid Waste.* Establish feasibility and recommend practical systems for energy recovery from waste material processes and determine the net energy balance.
- *Geothermal Power.* Determine locations of geothermal resources in proximity of naval bases and investigate power systems capable of extracting energy from these resources.
- *Photovoltaic Power Systems.* Evaluate photovoltaic power systems to satisfy Navy facility demand and operational requirements.
- *Solar Thermal Electric Systems.* Analyze solar thermal electric power hardware under development by DOE for Navy applications.
- *Solar Heating and Cooling.* Investigate and recommend collection systems for heating and cooling of buildings or providing a source of heat for thermal processes.
- *Wind Energy Systems.* Evaluate wind power generation systems integrated with building environmental systems or electrical power grids.
- *Optimal Planning of Energy Systems.* Determine advanced power system and energy conservation application criteria, the penetration of these systems into the shore establishment, and the methodology for optimizing mixtures of systems in planning new shore facilities.
- *Site Characteristics.* Acquire and analyze on-base energy resource data, climatic data, energy end-use consumption data, and system operating records at naval installations as input to feasibility and planning studies.
- *Wave Energy Technology.* Evaluate wave energy power generation for near-shore naval bases.

Coal Conversion/Reconversion

Responsible Activity

MILCON: NAVFAC (FAC-111)
RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

The Navy will monitor new coal systems being developed by other federal agencies such as DOE and by industry. The most economical approaches to converting to coal will be determined by analyzing and comparing the various options for burning coal directly or converting coal to a gas or liquid fuel, and for controlling particulate and gaseous emissions. The cost of replacing many existing small boilers for conversion to coal compared with centralized steam generation will be determined as well as continued purchase of electric power versus centralized electricity generation at a Navy base.

Technology developments in low-Btu coal gasification will be monitored since it is projected that beyond 1985 coal gasification would be the most economical approach to produce a turbine fuel for cogeneration at Navy facilities.

DOE will fund a demonstration of a 50,000 pound per hour atmospheric fluidized-bed boiler at the Great Lakes Naval Training Center and the Navy will provide personnel and facility support.

Emission reduction techniques will be investigated, including those being studied by the Environmental Protection Agency (EPA) and at several commercial demonstration plants. Flue gas desulfurization, one of the more advanced technologies for controlling the emission of sulfur oxides, will be used until an improved technology becomes available.

Work has begun on preliminary engineering and planning to reconvert to coal 15 oil- or natural gas-fired facilities which formerly were coal-fired. At eight installations, extensive architectural and engineering studies have been conducted to determine the economics of the relatively high-cost conversions and subsequent O&M costs.

Major conversion project sites include:

- Marine Corps Base, Camp LeJeune (completed).
- Naval Shipyard, Charleston (completed).
- Submarine Base, Bangor (completed).
- Public Works Center, Norfolk (under construction).
- Marine Corps Air Station, Cherry Point (under construction).
- Public Works Center, Great Lakes (under construction).

Reliability studies will begin in FY 1979 to select additional projects.

Required Funding Level

MILCON funds will be requested as projects are identified.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level		Required Funding Level	
Btu $\times 10^{12}$	6.9	Btu $\times 10^{12}$	14.5
Barrels $\times 10^{3}$	1,190.0	Barrels $\times 10^{3}$	2,500.0
$ Millions (1978 dollars)	20.4	$ Millions (1978 dollars)	42.8

Solar Energy Systems

Responsible Activity

RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

NAVFAC is pursuing the preliminary design and demonstration of several advanced solar energy applications. These include demonstration of solar collectors for Navy housing, determination of the applicability of solar electric photovoltaics, design of a solar air-turbine generator, solar desalination, tests of a solar augmented heat pump (SAHP), evaluation of solar related energy storage techniques, and utilization of wind energy conversion.

DOE's solar heating and cooling program will be monitored for incorporation of the technology into the Navy system. The Advanced Energy Utilization Test Bed (AEUTB), constructed for the study of thermal engineering of typical Navy buildings, will be used to test full-scale solar collectors, storage techniques, heat pumps, and other HVAC systems, either individually or integrated with other building systems. Performance will be analyzed by computer techniques and characterized for the local climatic conditions characteristic of Navy facilities. Experimental data will be used to verify the computer model.

Industry and DOE development of solar electric power generation systems will be monitored and evaluated for possible application and demonstration at Navy bases. A profile of the Navy's electrical needs will be obtained. A systems analysis will then define optimum solar electric configurations to best match these needs. The Navy will likely fund the design of a 10 kW Brayton cycle generator as part of DOE's small solar thermal power systems program, in parallel with the Stirling cycle, Rankine cycle, and minipower tower systems currently funded by DOE. Upon completion of the design phase, DOE will build and test all of the competing systems, with Navy participation throughout the development cycle for all the systems. Major milestones include:

- September 1980—Complete preliminary design of Brayton cycle system.
- September 1982—Participate in DOE program and design reviews of small solar thermal power systems.

Desalination methods will be studied to determine which can be economically powered with solar energy. The most suitable remote Navy base for a solar desalination plant will also be identified. A systems study will then be performed to determine the best method to be used at the selected Navy installation. Design concepts will be tested, evaluated, and developed, culminating in the installation of one or more units at the selected Navy base. Major milestones include:

- December 1978—Review contractor test results.
- September 1979—Begin preliminary design of full-scale system.

CEL has completed a study that indicates that SAHP technology is not economically feasible at this time.

Dissolved salts and chemical storage concepts developed in the national program will be studied to provide the necessary data to improve solar systems currently available and practical for Navy applications. Suitable dissolved salts phase-change materials and chemical decomposition reactions will be surveyed and identified. Laboratory experiments will be performed, and an engineering study will be conducted to determine capital costs and efficiency for a typical full-scale system. A comparative study of energy storage applications technology will then be performed.

The state of the art of advanced power cycles (fuel cells, Stirling, high-temperature Brayton or Rankine) will be monitored for potential applications and ultimate demonstration at Navy facilities. Engines and burners using these cycles can operate on locally synthesized fuels (hydrogen, ammonia, and methanol) and thus aid Navy energy self-sufficiency. Major milestones include:

- Continuing—Monitor state of the art of advanced power cycles.
- September 1979—Monitor existing contract on energy storage applications at NWC, China Lake.
- September 1980—Evaluate alternative concepts of dissolved salts and chemical storage for specific Navy applications.
- September 1982—Define energy storage requirements for Navy-wide applications.

Developments in the national wind energy program will be followed to adapt them to Navy needs and develop methodologies for Navy implementation. Small wind turbine generators integrated with the electrical grids will be evaluated for the production of electricity at Navy installations. Two such efforts presently in progress utilize a 6 kW variable-speed wind turbine generator with a single-phase synchronous inverter at the AEUTB, and a 20 kW variable-speed turbine with a three-phase synchronous inverter at Kaneohe Bay, Hawaii.

Small wind turbine generators for building power supply and space heating nongrid applications will be examined using horizontal-axis, three-bladed wind turbines driving three-phase AC generators. Automatic load-matching equipment will be field tested to determine the optimum system for converting variable output of the wind generator to match the electrical characteristics of Navy building equipment and facilities. A 2 kW wind turbine will be evaluated at the AEUTB, and a 5 kW system will be evaluated at San Nicolas Island for space heating applications.

Remote site application of wind turbine generators will be investigated initially at NWC, China Lake, with a 5 kW machine connected to the existing diesel generator bus.

Applications of DOE-developed large-scale wind turbine generators will be investigated by following DOE developments and initiating site evaluation procedures. Candidate sites will be selected based on cost-effectiveness and potential contribution to energy supply. Long-term field measurements of site wind characteristics will be taken and analyzed for

siting a 100 to 200 kW DOE unit at a Navy base. Major milestones include:

- Continuing—Evaluate sites for application of DOE large-scale wind turbine generator.
- Continuing—Evaluate (at new site) 20 kW wind turbine generator presently located at Kaneohe Bay.
- September 1979—Acquire wind data at Pinon Point; evaluate 5 kW wind turbine generator at San Nicolas Island, and select site for system relocation.
- January 1980—Evaluate 6 kW wind turbine generator at AEUTB for Navy applications and select site for system relocation.
- September 1981—Evaluate 2 kW wind turbine generator for Navy nongrid applications.

Required Funding Level

Funding is included for implementation of PL 95-356 (MILCON Authorization Act of FY 1979), which requires 25 percent of the estimated value of new construction facilities (except family housing) placed under design to include solar energy systems.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level		Required Funding Level	
Btu $\times 10^{12}$	0.9	Btu $\times 10^{12}$	2.7
Barrels $\times 10^{3}$	150.0	Barrels $\times 10^{3}$	465.0
$ Millions (1978 dollars)	2.6	$ Millions (1978 dollars)	8.0

Geothermal Resource Development

Responsible Activity

MILCON: NAVFAC (FAC-111)
RDT&E: NAVMAT (MAT-08T3)

O&M,N: NAVFAC (FAC-111)

Description

FYDP Funding Level

The potential for using geothermal energy to supply electrical power and space heating to Navy facilities will be assessed at the Coso geothermal resource area, NWC, China Lake, California; Fallon, Nevada; Adak, Alaska; Norfolk, Virginia; and other promising sites selected during exploratory studies.

Geological, geophysical, and geochemical analyses will provide preliminary information on the location and size of the geothermal resource and on the potential of developing the resource for Navy purposes. Concurrent with resource analysis, economic feasibility of developing the resource will be determined. If recommended, exploratory drilling will begin, supported by environmental studies appropriate for each site. In the case of Coso, full development of the field using private industry and private capital will proceed. Energy conversion devices being developed in other Navy alternative energy programs are being evaluated for use with geothermal fluids. Major milestones include:

- September 1978—Complete analysis of preliminary work at Adak including analysis of data from test holes.
- December 1978—Drill preliminary hole at Norfolk, Virginia, and analyze results.
- January 1979—Evaluate results of testing deep hole with respect to geothermal potential at Coso, China Lake, California.
- January 1979—Develop project plan for Adak.
- December 1979—Award contract for development of Coso.
- January 1980—Start initial phase of Keflavik development.
- June 1980—Conduct further exploratory drilling at Adak.
- July 1980—Award contract (similar to Coso) for development at Fallon if geothermal potential warrants.
- FY 1982—Begin construction of Coso geothermal power plant.
- FY 1982—Begin operation of Keflavik geothermal space heating system.
- FY 1983—Begin construction of Fallon geothermal power plant.
- FY 1984—Begin operation of Coso power plant.
- FY 1985—Begin operation of Fallon power plant.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

Btu $\times 10^{12}$	0.8
Barrels $\times 10^{3}$	137.9
$ Millions (1978 dollars)	2.4

Refuse-Derived Fuel Systems

Responsible Activity

MILCON: NAVFAC (FAC-111)
RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

Technologies for efficient recovery and burning of solid waste will be evaluated in terms of reliability, maintainability, safety, instrument landing system requirements, and overall energy efficiency.

Two different 40-ton-per-day packaged heat-recovery incinerators operating at NAS Jacksonville and NAS Mayport will provide data to determine the conditions, particularly minimum capacity, under which either type of heat-recovery incinerator facility would be cost-effective and sufficiently reliable elsewhere in the Navy shore establishment. At Jacksonville, the costs and benefits of preprocessing refuse into waste-derived fuel (WDF) for use in the incinerator will be determined. The characteristics of WDF required for cofiring with coal in Navy boilers or for use as a feedstock in other conversion processes such as pyrolysis will be studied.

A 180-ton-per-day water-wall trash-to-steam incinerator has been operated at the Navy Base in Norfolk, Virginia, since 1967. An 80-ton-per-day steam-producing incinerator is nearing completion at the Naval Shipyard (NSY) Portsmouth (VA), NAS Jacksonville, and NAS Mayport. The Navy is evaluating various other Navy locations to determine the feasibility of constructing new solid-waste-fueled plants or converting existing fossil-fueled plants. Construction is planned to begin in FY 1982 on a solid waste fuel fired plant at NSY Philadelphia which will be contractor funded and operated.

The Navy will test and evaluate the segregation and processing of solid waste to manufacture a refuse-derived fuel (RDF) that can be burned with coal to produce low-cost steam. In advance development, CEL plans to verify theoretical data during FY 1979 to 1981 by obtaining data on a 50-ton-per-day system operating at the Navy's new waste heat incinerator at NAS Jacksonville. This effort will be designed to ascertain the costs of producing RDF, to determine the reliability of existing equipment, and to gain knowledge in handling and mixing RDF with other fuels.

Major milestones include:

- July 1979—Procure and install components of a basic demonstration prototype.
- September 1979—Perform initial tests to determine parameters for RDF procurement specification.
- September 1980—Test fuel combustion characteristics to refine specification.
- September 1981—Test and demonstrate packaged incinerator systems for comparative evaluation of various operating modes, including different types of RDF.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

Btu $\times 10^{12}$	2.8
Barrels $\times 10^{3}$	474.0
$ Millions (1978 dollars)	8.1

Energy Self-Sufficiency Studies/Demonstration

Responsible Activity

RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

The Sewell's Point Naval Base will be analyzed to identify end uses of energy on a seasonal basis. Work began with on-site conferences at NAVFAC, Atlantic Division, and PWC, Norfolk. Tentative measurement sites were selected and general agreement reached on the objectives to be attempted. Decisions have been made on the instrumentation requirements and specifications and acquisition of equipment has been initiated. Major milestones include:

- September 1978—Obtain instrumentation system and modify as needed.
- March 1979—Measure winter usage of electricity and steam.
- August 1979—Measure summer usage of electricity and steam.
- September 1979—Analyze data and issue documentation.

A self-sufficiency plan is to be prepared for NWC, China Lake, showing a time-phased conversion to on-base renewable energy sources. Demand and resource profiles will be identified and candidate conversion systems examined. Special emphasis will be placed on geothermal sources and conversion of solid waste to fuel. Due to large on-base resources, mainly geothermal, the particular possibility of energy export off-base will be addressed. This project will begin in FY 1979 and the plan should be completed by September 1980.

A self-sufficiency plan is to be prepared for the Pacific Missile Test Center (PMTC), showing a time-phased conversion to on-base renewable energy sources. The energy planning and optimization model will be extended and applied to PMTC, reflecting current NAVFAC guidance, with special emphasis on wind and solar utilization. This project will begin in FY 1979 and the plan should be completed by September 1980.

SHIP OPERATIONS

As part of its ship operations energy program, the Navy is pursuing improved hull maintenance/drag reduction, shipboard machinery optimization, advanced ship components, performance monitoring, water resource management, and testing of light refined synthetic fuels for ships. These activities, which in the past have been primarily funded as exploratory and advanced development R&D programs, are now being implemented for fleet operations. In particular, underwater hull cleaning will be initiated on a semiannual basis in FY 1979 and by FY 1982 a program of applying new improved hull coatings will be initiated. This program includes:

- Energy Conservation
  - — Exploratory Development
  - — Improved Hull Maintenance
  - — Combustion Optimizer
  - — Advanced Ship Components
  - — Shipboard Machinery Optimization
  - — Performing Monitoring
  - — Water Resource Management
- Synthetic Fuels
  - — Synthetic Fuels for Ships

Ship Energy Exploratory Development

Responsible Activity

RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

The Navy ship exploratory development program emphasizes the reduction of fuel consumption by the future fleet through the use of alternative propulsion and auxiliary subsystems. The David W. Taylor Naval Ship Research and Development Center (DTNSRDC) is the primary Navy laboratory for conducting the shipboard energy conservation program.

For diesel and gas turbine powered Navy ships, the propulsion, electrical, and auxiliary systems are designed independently within constraints such as size, weight, and cost, to meet certain minimum performance requirements. Each system is therefore sized to ensure that peak demands can always be met. As a result, the overall plant efficiency at part load, at which the ship operates most of the time, can be quite low. The efficiency of shipboard machinery systems will be improved through a coordinated total energy systems approach. This approach will allow quantification of energy flows throughout the entire system at all operating conditions, thereby allowing for optimization of energy usage, while at the same time meeting peak demands. Total energy analysis for any given ship type involves:

- Determining hull resistance and propeller characteristics from analytical/experimental methods, as available, for a reference hull form.
- Defining the auxiliary requirements at each operating condition being considered.
- Developing a candidate energy system configuration based on previous propulsion and electrical systems studies, and revising the above data to reflect changes in ship displacement and size.
- Performing a complete energy balance for the system at each operating condition, and calculating total fuel consumption over the operating profile.
- Establishing performance requirements of the baseline systems.
- Analyzing the baseline for energy intensifier systems and configurations.
- Conducting state-of-the-art surveys.
- Synthesizing alternative configurations that offer the greatest potential for reducing fuel consumption.
- Preparing a life-cycle cost analysis for attractive concepts to determine payback.

The suitability of alternative fuel sources for the production of military fuels is to be determined and samples of synthetic fuels, acquired from various pilot demonstration and commercial sources, will be screened through the tests required by the appropriate Military Specification (MILSPEC) (e.g., JP-5, DFM, etc.). On the basis of these screening tests, can-

didate fuels will be characterized by physical and chemical properties. If a candidate fuel appears suitable, it will be recommended for test and evaluation in the 6.3 program. Fuels found unsuitable may be studied to inform the manufacturer of deficiencies and of refinements necessary to satisfy Navy requirements. If the fuel shows no potential, it will be eliminated from consideration.

Crude assay analyses of various synthetic crudes will be conducted to determine the potential yield and quality of MILSPEC fuels. These analyses will be conducted in cooperation with DOE and other DOD laboratories. In addition to operational fuel considerations, these assay analyses will further identify potential sources of other synthetic products (lubricants, hydraulic fluids, etc.) of interest to the Navy.

Improved Hull Maintenance

Responsible Activity

RDT&E: DTNSRDC/A

Description

FYDP Funding Level

The improved hull maintenance program includes underwater hull cleaning, improved hull coatings, and noncoating biofouling protection. Improved underwater hull cleaning will reduce the fuel consumption of naval ships through the periodic removal of biofouling from underwater surfaces. Specific goals include the development of cost-effective cleaning procedures, determination of optimum cleaning frequencies, and promulgation of guidance to the fleet.

Biofouling, in the most simple sense, can be characterized as the attachment and subsequent growth of various marine organisms on nontoxic surfaces. These organisms will form on hull surfaces as well as on the interiors of sea chests. The accumulation of fouling on ships' hulls and appendages represents the single largest fuel consumption penalty identified to date. Specific instances have been observed where hull efficiency has been degraded by greater than one third after relatively short periods out of drydock. In addition to fuel consumption penalties there are the even more serious ancillary impacts of reduced operational capabilities in terms of speed, endurance range, and self-noise generation.

Existing antifouling paint systems will not remain fouling-free for extended periods of time without surface rejuvenation. It is therefore necessary to develop procedures which will remove fouling and depleted surface layers without adversely affecting the remaining coating performance. Additionally, fouling is a random phenomenon which occurs at different rates and consists of different species depending upon theater of operation and percent of time under way. The degree of such fouling dictates the required severity of the cleaning procedure as well as the maximum interval between subsequent cleanings. These variables must be quantified to establish a comprehensive hull cleaning policy. Major milestones include:

- December 1978—Instruct fleet on how to clean ships' hulls and conduct sea trials on cleaning Atlantic and Pacific fleet ships.

Improved hull coatings are needed to reduce the fuel consumption of naval ships through the elimination of biofouling from ships' hulls for five years by development of an improved antifouling coating. Candidates under investigation are based on the organometallic polymer (OMP) principle which must be compatible with present Navy anticorrosion paint systems, present shipyard paint application technology, and both present and future environmental and Occupational Safety and Health Administration safety requirements.

Although periodic cleaning restores the operational capability of a ship, it is always

labor intensive to some degree, and temporary at best. The only complete solution is one which will prevent any degradation in ship performance between regularly scheduled drydockings. The OMP program is intended to provide this capability. Major milestones include:

- December 1978—Begin shipboard application and evaluation of antifouling paints.
- March 1980—Complete ship evaluation of antifouling paints.
- July 1980—Prepare large batch formulations for testing.
- September 1982—Begin fleet implementation of antifouling paint.

Improved noncoating biofouling protection is needed to prevent the attachment of marine organisms to the interiors of sea chests during in-port periods when the steam plant is inactive. Biofouling which forms on these interior surfaces cannot be easily removed because of permanently installed sea chest gratings. The consequences of unchecked buildup of fouling are that eventually the passage could become too restricted to permit the flow of water to condensers; or more likely, some types of fouling will become dislodged and clog condenser tubes.

The interiors of sea chests are presently coated with standard Navy antifouling paint which becomes inactive or suffers adhesion failures after relatively short periods compared to ship overhaul intervals. At present there is no effective means of cleaning anything other than the grating to maintain or restore maximum heat exchange efficiency of the condensers. The long-term goal is to develop coatings which will be resistant to fouling for requisite periods. The short-term goal is to develop noncoating systems which can be activated whenever the ship is in-port in a "cold-iron" condition.

The approach to noncoating biofouling prevention is through the application of ultrasound using magnetostrictive, piezoelectric, or polymeric transducers which are either mounted on the walls of the sea chests or suspended in the center; or piezoelectric films applied to the walls of the chamber. Investigations involve determinations of the optimum transducer placement, power level, frequency, mode of operation (i.e., static or swept), and human factors. Preliminary experiments involve suspension of a series of plates from a raft and irradiation with a series of beam patterns and acoustic intensities. A simulated sea chest then will be irradiated with those frequencies which were most effective in the flat plate experiments to determine the effects of geometry and mode of operation. The objective is to determine what discrete frequencies and power levels result in repulsion of marine organisms. Considerable work in this area has been done in Britain, France, Japan, and the Soviet Union with encouraging results. At the conclusion of the current field tests, a shipboard system will be constructed and evaluated.

Annual Energy Savings (Beginning in 1985)

FYDP Funding Level

Btu $\times 10^{12}$	18.3
Barrels $\times 10^{3}$	3,162.0
$ Millions (1978 dollars)	54.1

Combustion Optimizer

Responsible Activity

RDT&E: DTNSRDC/A

Description

FYDP Funding Level

In engineering development, DTNSRDC is developing a fully automatic combustion control system based on the oxygen analysis principle that will maintain boiler combustion air at peak efficiency during all conditions of command. This new technique will result in approximately a 6 percent reduction in fuel consumption on major ship classes. A specification to procure two analyzer systems for use on 1,200-psi plants will be prepared—one based on in-situ analyzers, the other on extraction techniques. Major milestones include:

- March 1978—Receive combustion control system.
- October 1979—Install system on board ships.
- February 1980—Complete operations evaluation of combustion control system.
- March 1980—Complete final report recommending the preferred system, and complete training requirements.

Required Funding Level

Installation of units on 36 ships (23 four-boiler and 13 two-boiler) will begin in FY 1983, provided that FY 1982 funding is available.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

There are no savings at this funding level.

Required Funding Level

Btu $\times 10^{12}$	3.8
Barrels $\times 10^{3}$	653.0
$ Millions (1978 dollars)	11.2

Advanced Ship Components

Responsible Activity

RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

Advanced development work at DTNSRDC will provide for model tests and hardware demonstrations of machinery systems and components that have the potential to reduce fuel consumption through improved efficiency, without reducing the effectiveness and mission capability, of future nonnuclear ships and craft. The feasibility of combining the technologies developed during the exploratory development phase into technological building blocks will be demonstrated experimentally. The goal is to provide proof of the advantage to be gained through the application of new technology, as well as to define additional development necessary before proceeding to the engineering development program. Specific tasks currently under way or planned for initiation in FY 1978 deal with propulsion-derived ship service power, reverse osmosis desalination, improved hull design, diesel noise analysis, heat-powered air conditioning, and advanced pumping systems.

Engineering development work will focus on qualifying full-scale propulsion, electrical, and auxiliary systems for present and future fleets. Major milestones include:

- January 1978—Initiate noise analysis and conceptual design of auxiliary diesel generators.
- March 1978—Initiate improved pump system development; improve ultrafiltration technique for reverse osmosis desalination; complete alternative system assessment of heat-powered air conditioning.
- May 1978—Initiate hardware development for heat-powered air conditioning.
- September 1978—Complete improved hull design analysis; improve membranes and automatic start-up/shutdown for reverse osmosis desalination.
- December 1978—Test hull appendage model.
- September 1979—Complete propulsion test; complete high pressure brine pumps.
- December 1979—Complete system design for reverse osmosis desalination.
- August 1980—Complete technical evaluation of auxiliary diesel generators.
- May 1982—Issue recommendations for fleet implementation of auxiliary diesel generators.

Shipboard Machinery Optimization

Responsible Activity

RDT&E: DTNSRDC/A
OPN: NAVSEA

Description

FYDP Funding Level

In engineering development, fuel consumption of existing steam-powered ships is to be reduced by at least 10 percent through the identification of energy-intensive machinery systems and operational procedures and the recommendation of modifications to effect major energy savings. The numerous variables associated with ship machinery, such as mission, steaming hours, and individual equipment settings and operations, will be monitored in detail under strictly controlled conditions. After detailed analysis of such variables, work will be done to improve the operating procedures of the various machinery and thus reduce fuel consumption. Also, diagnostic information on hull and power plant condition will be provided to ship operators to enable immediate rectification of the effects of system malfunction/degradation and elimination of increased fuel consumption. Major milestones include:

- December 1977—Complete sensitivity analysis and make FF 1074 recommendations.
- December 1978—Complete analysis of major auxiliaries.
- June 1979—Complete system development for shipboard machinery performance monitoring.
- December 1979—Complete analysis of major amphibious ships.
- January 1980—Make recommendations for implementing shipboard machinery performance monitoring.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

Btu $\times 10^{12}$	0.6
Barrels $\times 10^{3}$	103.0
$ Millions (1978 dollars)	1.8

Performance Monitoring

Responsible Activity

RDT&E: DTNSRDC/A

Description

FYDP Funding Level

The objective of this program is to provide diagnostic information to ship engineering officers concerning hull and power plant condition, thereby enabling immediate rectification of the effects of system malfunctions/degradation and elimination of increased fuel consumption.

As a result of findings during the Machinery Optimization program, Naval Sea Systems Command (NAVSEA) has identified areas of potential energy savings through continual performance monitoring.

Initially, NAVSEA will define the causes of nonoptimum operations aboard ship. These include areas such as design deficiencies, operator error, necessary maintenance, or system/component degradation.

From these determinations, performance monitoring is expected to:

- Provide an indication of deviation from optimum system heat balance.
- Provide a quantitative basis for timely correction.
- Promote a means for comparing different operating modes.
- Quantify before-and-after effects of remedial actions.

Water Resource Management

Responsible Activity

RDT&E: DTNSRDC/A

Description

FYDP Funding Level

In engineering development work, the DTNSRDC is identifying freshwater flow patterns aboard ship and formulating water resource management techniques to improve the efficiency of freshwater production and utilization aboard ship. Existing processes, operations, and activities consuming fresh water will be analyzed on an FF 1052 class frigate and aircraft carrier to identify potential payoff areas. Major milestones include:

- Complete laundry rinse water reuse laboratory evaluation.
- Install water storage control system.
- Prepare draft of fleetwide water management plan.
- Instrument USS Saratoga and USS McCandless to obtain long-term usage patterns.
- Install laundry water reuse system on USS Saratoga.

Required Funding Level

Implementation of water resource management techniques will begin in FY 1981 if funding is made available.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

There are no savings at this funding level.

Required Funding Level

Btu $\times 10^{12}$	1.9
Barrels $\times 10^{3}$	328.0
$ Millions (1978 dollars)	5.6

Synthetic Fuels for Ships

Responsible Activity

RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

Advanced development work includes performance of computer studies of synthetic fuel impact in terms of system compatibility, logistics and handling problems, fire and safety hazards, and toxicological effects. To allow greater flexibility, broader fuel specifications will be considered for petroleum-based fuels.

For synthetic fuels, initial boiler evaluation will be based on tests conducted with a single-burner test rig, and diesel engine evaluations will be based on tests conducted with small-scale (one- and three-cylinder) diesel test engines. Gas-turbine engine evaluations will be based on tests conducted with both single-can combustor and annular combustor test rigs. If, on the basis of the small-scale engine and laboratory test results, a particular synthetic fuel remains a viable candidate for fleet operational use, it will be recommended for full-scale engine test and evaluation. The tests will use generic engines, representative of the major populations of boilers, diesels, and gas turbines currently used or proposed for use in the fleet.

In the area of shipboard fuels flexibility, the feasibility of adopting a multifuel capability will be assessed. Should this assessment indicate that there are measurable cost and availability advantages to be realized by permitting the use of fuels that cannot be procured under current military specifications a determination will be made as to the degree and nature of the fuel flexibility that could be permitted without compromising fleet operational performance.

As part of the engineering development program, DTNSRDC will perform final sea-trial qualifications of synthetic and broadened specification petroleum-based diesel fuel marine for fleetwide use including identification of handling and personnel training requirements and evaluation of long-term effects on the operational environment.

Operational data will be available to allow use of broadened specification petroleum-based fuel by 1984 and synthetic hydrocarbon fuels by 1990.

AIRCRAFT OPERATIONS

As part of its aircraft investigations program, the Naval Air Systems Command (NAVAIR) is managing and implementing Navy activities in the DOD flight simulator program and is developing a computer flight planning and fuel management system. NAVAIR is also identifying those categories of Navy aircraft that are major fuel users and that are amenable to fuel conservation modifications, and testing synthetic JP-5 using T63 and TF34 engines. This program includes:

- Energy Conservation
  - — Exploratory Development
  - — Aircraft Investigations
  - — Current Inventory Component Optimization
- Synthetic Fuels
  - — Synthetic Fuels for Aircraft

Aircraft Energy Exploratory Development

Responsible Activity

RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

The Air Force is the lead DOD agency for aviation-related energy conservation programs. Therefore, the Navy has primarily a supporting role. The Navy aircraft energy conservation program was initiated in FY 1978. An analysis will be made of the fuel used by current Navy and Marine Corps aircraft by aircraft type and mission. Using these data and the rework schedules for current inventory aircraft, possible design changes/modifications and/or mission operational changes will be evaluated to reduce fuel usage. Analyses of the projected fuel use of "advanced" systems concepts will also be undertaken.

As part of the fuels project of the aircraft exploratory development program, an 18-month contract has been awarded Exxon to study the effects of changes in crude mix quality and the refinery operation variable necessary to produce a specification JP-5. This program will address potential fuel-hardware interactions as a result of these changes. In-house activity has detected a lower lubricity level for some of the domestically produced JP-5, which may be related to these shifts in crude quality and refinery practices. Efforts were initiated to study the feasibility of using relaxed specification fuel. The major problem is the identification of the fuel properties that will be relaxed and how the relaxation of a single property affects the overall fuel quality. Distillation of heavy fuels, such as diesel fuel marine, has shown that freezing point, viscosity, aromatic, and thermal stability are related to the variations in the distillation end point. The use of a 10 percent and 20 percent blend of diesel fuel marine and JP-5 as an emergency fuel is feasible under limited use conditions. Specification tests of 10 percent and 20 percent blends show the emergency fuel deficient in freezing point, thermal stability, and water releasing properties. Limited performance testing in a T63 engine (4 hours) show no problems. The blends showed acceptable combustion properties in the Phillips two-inch combustor and a T63 combustor can.

A fuel control test of 100 percent diesel fuel marine showed no performance problems. An oil shale JP-5 produced in the SOHIO pilot plant conformed to the JP-5 specification requirements. The aromatics were higher than an average JP-5 (23.7 percent compared to 16 percent). Ball and cylinder tests indicated that the fuel had lower lubricating properties, which could affect control and pump performance. A gas chromatography and mass spectrometer combination has been calibrated for characterization of refinery produced samples with respect to the alkane and aromatic content as well as the heteroatom concentration. The NMR carbon-13 technique will be used to identify specific structures, i.e., aromatic type. A statistical method has been evaluated as a tool for designing experiments for elucidating the effects of structure on fuel freezing point.

The Navy also has an exploratory development effort oriented toward the test and

evaluation of synthetic jet fuels from alternative sources. The Navy effort is coordinated periodically in sponsored group meetings with the Army Aviation System Command, National Aeronautics and Space Administration, and the Air Force Systems Command. The overall program involves testing synthetic jet fuels derived from oil shale, tar sands, and coal. The physical and chemical characteristics of synthetic-derived and nonspecification aviation fuels will be determined and compared with those of MILSPEC fuels. Distinctive characteristics of these fuels, along with possible safety, handling, compatibility, and performance problems, will be determined.

Aircraft Investigations

Responsible Activity

RDT&E: NAVAIR

Description

FYDP Funding Level

The Navy plans to develop energy conservation procedures for aircraft engine development and testing. Other work will focus on examining the use of winglets and other potential airframe, propulsion, or aerodynamic modifications, and aircraft operating procedures that will require only minor modification to improve energy conservation.

Current Inventory Aircraft Component Optimization

Responsible Activity

RDT&E: NAVAIR

Description

FYDP Funding Level

The Navy plans to identify those categories of Navy aircraft that are major fuel users and are amenable to modification for conservation purposes. Those aircraft will be examined in detail to determine which configuration changes and/or components can be modified profitably. Modifications will be made using existing technology, if possible.

Synthetic Fuels for Aircraft

Responsible Activity

RDT&E: NAVMAT (MAT-08T3)

Description

FYDP Funding Level

The Navy will conduct critical experiments to establish the technical, military, and economic feasibility of using, as soon as they are available, commercially produced synthetic military fuels made from domestic reserves of oil shale, tar sands, and coal. These synthetic fuels will be direct substitutes for today's military fuels from dwindling reserves of natural crude oil. Fuel flexibility work will include studies and tests to assess the impact (on availability, cost, performance, reliability, safety, etc.) of using broadened specification or relaxed nonmilitary-specification fuels from conventional sources to avoid compromising fleet readiness when MILSPEC fuels are unavailable or in short supply.

Advanced development work focuses on determining actual engine performance and emissions characteristics using T63 and TF34 engines. Engineering development seagoing flight tests are planned for final qualification of aircraft fuels verifying compliance with maximum performance requirements under conditions of actual carrier-dependent aircraft operations. Handling and safety expertise are also to be developed.

Plans for evaluating an oil shale JP-5 from the 88,000 barrel refinery experiment consists of:

- 100-hour TF30 engine test, which includes altitude and sea level starts, and emissions.
- A combustor endurance test.
- A fuel control test at simulated temperatures to study elastomer behavior.

A request for proposals has been prepared for studying new methods for evaluating nonaviation and synthetic fuels for Navy use. It is anticipated these methods will enable the Navy to study the acceptability of new fuels without a total reliance on expensive, time and energy-consuming engine tests.

Operational data will be available to allow use of broadened specification petroleum-derived fuels by 1984 and synthetic hydrocarbon fuels by 1990.

MARINE CORPS PROJECTS

Specific Marine Corps projects in response to the need to conserve energy in the operation of its shore facilities center around utilities and heating plants. Projects include:

- Energy Conservation
  - — Utilities Energy Engineering Study Surveys
  - — Use of Pelletized Wood in Coal-Fired Heating Plants
  - — Utilities Metering

Utilities Energy Engineering Study Surveys

Responsible Activity

O&M,MC: CMC (LFF-2)

Description

FYDP Funding Level

Effective management of utilities, master planning for future utilities support, and conservation of energy require complex technical analyses beyond in-house capability. Marine Corps activities utilities engineers and energy conservation officers have been requested to identify potential studies together with estimated costs and benefits/savings. It is expected that some of these studies will result in immediate savings through operational changes; other studies will provide input to the ECIP and the EEP.

Required Funding Level

Efforts will be accelerated to provide greater cost and energy savings.

Annual Energy Savings (Beginning in FY 1985)

FYDP Funding Level

As a result of this effort, significant energy and cost savings should result. These savings cannot be determined at this time.

Use of Pelletized Wood in Coal-Fired Heating Plants

Responsible Activity

O&M,MC: CMC (LFF-2)

Description

FYDP Funding Level

MCDEC Quantico, Virginia; MCB Camp Lejeune, North CCarolina;nd MCAS Cherry Point, North Carolina, are investigating the feasibility of burning pelletized wood in their existing central coal-fired heating plants. Potential advantages are substitution of a renewable energy source for coal and oil, reduced pollution, and reduced operation and maintenance costs.

Required Funding Level

Funding above the approved FYDP funding level may be required but the amount is unknown at this time.

Annual Energy Savings (Beginning in FY 1985)

Operation and maintenance savings are anticipated. However, the major benefit of this project is substitution of a renewable energy source for coal and oil. Estimated maximum coal/oil substitution is approximately 2.7 trillion Btu.

Utilities Metering

Responsible Activity

O&M,MC: CMC (LFF-2)

Description

FYDP Funding Level

Marine Corps activities have been requested to review utilities system metering requirements. However, no construction effort is planned under the approved FYDP funding level.

Required Funding Level

Utilities meters are effective in analyzing performance and controlling energy consumption and costs. Marine Corps activities will procure and install master meters for steam, high temperature hot water, gas, electricity, etc. wherever feasible and cost effective. The use of meters by energy conservation managers to monitor consumption of geographical areas, reimbursible customers, utility plants, large buildings, etc. will help meet planned conservation goals.

Annual Energy Savings (Beginning in FY 1985)

As a result of this effort, significant energy savings should result. These savings cannot be determined at this time.

GLOSSARY

AAW	Antiair Warfare
ACC	Automatic Combustion Control
ACEE	Aircraft Energy Efficiency
ACT-UP	Air Conditioning Tune-Up
AEUTB	Advanced Energy Utilization Test Bed
ASD	Assistant Secretary of Defense
ASN	Assistant Secretary of the Navy
ASW	Antisubmarine Warfare
BOE	Barrels of Oil Equivalent
BOQ	Bachelor Officers Quarters
Btu	British Thermal Unit
CECOS	Civil Engineering Corps Officers' School
CEL	Civil Engineering Laboratory
CG	Consolidated Guidance
CMC	Commandant of the Marine Corps
CNO	Chief of Naval Operations
CONUS	Continental United States
DASD	Deputy Assistant Secretary of Defense
DASD for I&H	Deputy Assistant Secretary of Defense for Installations and Housing
DC/S	Deputy Chief of Staff
DC/S for I&L	Deputy Chief of Staff for Installations and Logistics
DEIS	Defense Energy Information System
DEMC	Defense Energy Management Cycle
DEP	Defense Energy Policy
DEPC	Defense Energy Policy Council
DEPPM	Defense Energy Program Policy Memorandum
DFM	Diesel Fuel, Marine
DFSC	Defense Fuel Supply Center
DLA	Defense Logistics Agency
DOD	Department of Defense
DOE	Department of Energy
DTNSRDC	David W. Taylor Naval Ship Research and Development Center
DTNSRDC/A	David W. Taylor Naval Ship Research and Development Center, Annapolis
ECAM	Energy Conservation and Management
ECIP	Energy Conservation Investment Program
EEP	Energy Engineering Program
EES	Energy, Environment and Safety
EFD	Engineering Field Division
EMCS	Energy Monitoring and Control System
EPA	Environmental Protection Agency
ERA	Economic Regulatory Administration
ETAP	Energy Technology Applications Program
FTC	Flight Test Center
FY	Fiscal Year
FYDP	Five Year Development Plan
GAO	General Accounting Office
GOCO	Goverment-Owned, Contractor-Operated
HFSSB	High Frequency Solid-State Ballast
HVAC	Heating, Ventilating and Air Conditioning

IA	Interagency Agreement
IOC	Initial Operating Capability
MARAD	Maritime Administration
MCAS	Marine Corps Air Station
MCB	Marine Corps Base
MCO	Marine Corps Order
MEFS	Mid-Term Energy Forecasting System
MERADCOM	Mobility Equipment Research and Development Command
MILCON	Military Construction
MILSPEC	Military Specification
MOU	Memorandum of Understanding
MRA&L	Manpower, Reserve Affairs and Logistics
MSC	Military Sealift Command
NA	Naval Academy
NAF	Naval Aircraft Factory
NAPTC	Naval Air Propulsion Test Center
NAS	Naval Air Station
NASA	National Aeronautics and Space Administration
NATC	Naval Air Test Center
NAVFAC	Naval Facilities Engineering Command
NAVMAT	Naval Material Command
NAVPETOFF	Navy Petroleum Office
NAVSEA	Naval Sea Systems Command
NAVSEC	Naval Ship Engineering Center
NAVSECGRUACT	Naval Security Group Activity
NEA	National Energy Act
NETC	Naval Engineering Technical Center
NEUPAS	Navy Energy Usage Profile and Analysis System
NPGS	Naval Post Graduate School
NPWC	Navy Public Works Center
NS	Naval Station
NSC	Naval Supply Center
NSY	Naval Shipyard
NTC	Naval Training Center
NWC	Naval Weapons Center
OMB	Office of Management and Budget
O&M	Operations and Maintenance
O&M,N	Operations and Maintenance, Navy
OMP	Organometallic Polymer
OPNAV	Naval Operations
OSD	Office of the Secretary of Defense
PMTC	Pacific Missile Test Center
POL	Petroleum, Oil and Lubricants
PPBS	Planning, Programming and Budgeting System
PWC	Public Works Center
PWRMR	Prepositioned War Reserve Material Requirements
R&D	Research and Development
RD&D	Research, Development and Demonstration
RDF	Refuse-Derived Fuel
RDT&E	Research, Development, Test and Evaluation
RE&S	Research, Engineering and Systems
SAHP	Solar Augmented Heat Pump
SECNAV	Secretary of the Navy
SIFPPS	Shore Installation Facilities Planning and Program System
SIR	Savings-to-Investment Ratio

SOHIO	Standard Oil of Ohio
STEM	Shipboard Total Energy Model
SSW	Surface Ship Warfare
SYSCOM	Systems Command
USGS	U. S. Geological Survey
WDF	Waste-Derived Fuel

APPENDIX A
PATTERNS OF ENERGY USAGE IN THE U.S. DEPARTMENT OF THE NAVY

APPENDIX A

PATTERNS OF ENERGY USAGE IN THE U.S. DEPARTMENT OF THE NAVY

The Navy Energy Usage Profile and Analysis System (NEUPAS) is a Navy-wide system to collect, verify, and present energy usage data. Data for FY 1975 are for the adjusted baseline year, 1 October through 30 September, and FY 1977 and FY 1978 data are for actual usage.

Fuel usage data for petroleum fuels were obtained from the David W. Taylor Naval Ship R&D Center, Annapolis, NEUPAS computer printout. Shore utility data were obtained from the Naval Facilities Engineering Command (NAVFAC) and the Commandant of the Marine Corps. Fuel survey data were provided by the Navy Petroleum Office (NAVPETOFF) Petroleum, Oil and Lubricants (POL) survey reports. Aircraft simulator substitution savings were estimated for FY 1975 and provided by OP-59C for FY 1977 and FY 1978.

Navy energy costs were determined from two sources. Mobility petroleum fuel costs were obtained from Defense Fuel Supply Center price bulletins and multiplied by actual fuel usage. Shore utility costs, including shore heating oil, were provided by NAVFAC.

Table A-1 shows the conversion factors used in the energy profile system. Because the heating or thermal value of a fuel is related to its API gravity, an average value for each fuel type was used. Table A-2 shows the average Navy energy costs by energy form for FY 1975, and FY 1977 through FY 1979.

As shown in Figure A-1, the Navy realized a total energy reduction of 8.1 percent (revised since the 1978 plan) in FY 1977 and 9.5 percent in FY 1978, compared with the baseline year of FY 1975. The greatest reduction to date has been achieved by ships, which used 19.4 percent less energy in FY 1978 than in FY 1975. Aircraft energy usage decreased 6.8 percent, shore facilities energy usage decreased 3.1 percent, and ground support energy usage decreased 7.4 percent.

Figure A-2 shows Navy energy costs. Although energy usage was reduced by 8.5 million barrels of oil equivalent (BOE) between FY 1975 and FY 1978, the Navy's energy bill showed a $148 million increase. (An upward trend in prices for the various energy forms in Table A-2 explains this increase.) Energy costs increased $81 million between FY 1977 and FY 1978.

Figure A-3 illustrates the changing pattern of energy usage in the Navy. Generally, less petroleum is being used, and more electricity is being used by facilities than natural gas. Coal usage has declined, but is expected to increase in future years. Petroleum fuel usage by fuel type is shown in Figure A-4.

Table A-1. ENERGY CONVERSION FACTORS

Energy Form	Quantity Unit	Btu[a] per Quantity Unit
Automotive gasoline	bbl[b]	5.25×10^6
Aviation gasoline	bbl	5.25×10^6
Jet fuel, JP-4	bbl	5.34×10^6
Jet fuel, JP-5	bbl	5.67×10^6
Kerosene	bbl	5.67×10^6
Diesel fuel	bbl	5.83×10^6
Distillate fuel oil, No. 2	bbl	5.83×10^6
Navy distillate fuel oil (ND)	bbl	5.95×10^6
Navy special fuel oil (NSFO)	bbl	6.22×10^6
Residual fuel oil, Bunker C	bbl	6.29×10^6
Propane	gal	95,500
Natural gas	SCF[c]	1,031
Coal, bituminous	short ton	24.58×10^6
Steam	lb	1,000
Electricity	kWh	11,600[d]
Barrel of oil equivalent (BOE)[e]	bbl	5.8×10^6

[a]British thermal unit (Btu).
[b]1 barrel (bbl) = 42 U.S. gallons.
[c]Standard cubic foot (SCF).
[d]NAVFAC value—includes energy production and transmission losses. (U.S. National Bureau of Standards value is 3,412 Btu/kWh and does not include production and transmission losses.)
[e]1 million BOE = 10^6 BOE.

Table A-2. AVERAGE NAVY ENERGY COSTS BY ENERGY FORM

Energy Form	FY 1975[a]	FY 1977	FY 1978	FY 1979[b]
Petroleum fuels ($/bbl)				
AVGAS	18.67	19.19	23.39	24.78
MOGAS	16.44	13.22	22.81	21.29
JP-4	16.13	18.19	17.64	18.35
JP-5	15.41	16.17	18.52	19.15
DFM	14.80	16.17	18.52	18.86
NDF	14.88	16.17	18.52	18.86
NSFO	13.81	13.15	17.39	17.01
Residual	13.81	13.15	17.39	17.01
Shore heating oil	13.15	14.11	14.83	15.17
Average petroleum cost[c]	14.87	15.89	17.90	18.36
Electricity ($/MWh)	24.48	28.75	31.31	31.34
Natural gas ($/million Btu)	0.99	1.76	1.96	2.00
Propane ($/million Btu)	3.54	4.41	4.77	4.84
Coal ($/ton)	39.51	33.92	43.00	43.57
Steam and hot water ($/million Btu)	2.72	4.36	–	–

[a]Modified to cover 1 October through 30 September.
[b]Preliminary.
[c]Computed on basis of total barrels of each fuel used.

Petroleum costs are detailed in Figure A-5. After an initial drop in cost due to the government-ordered fuel price rollback in FY 1976, prices began to rise again. The FY 1978 fuel price shows the full effect of these increases.

As shown in Figure A-6, the major ship classes decreased their energy usage from FY 1975 to FY 1978. (FY 1975 ship energy usage data has been revised due to a change in data for carriers.) Figure A-7 shows petroleum usage for ships by fuel type. Usage of all fuels has decreased, except diesel fuel, marine, which is quickly becoming the dominant fuel for Navy ships. A comparison of ship energy usage (in Figure A-6) with ship activity as measured by steaming hours (in Figure A-8) reveals that decreases in ship energy usage were significantly influenced by reductions in steaming hours, both underway and not underway.

Figure A-9 presents the calculated usage rate per average underway steaming hour. The overall performance of ships measured in this manner has increased 1.8 percent in fuel usage per average underway steaming hour from FY 1975 to FY 1978. However, this increase in fuel consumption per average underway steaming hour is not a true picture of ship performance. Figure A-10 compares FY 1978 underway steaming hour energy usage with the usage which would have occurred had the ships operated FY 1978 hours at FY 1975 consumption rates for selected ship classes. This comparison shows a net decrease in underway steaming hour energy consumption of about 260,000 barrels of petroleum, a decrease of 1.7 percent from FY 1978 hours at FY 1975 consumption rates.

Figure A-11 shows the results of fleet fuel surveys. The Navy's goal is a 90 percent reduction in surveys from the FY 1975 baseline. An excellent start has been made; the Navy achieved a 50 percent reduction in fuel surveys between FY 1975 and FY 1977, but only a 39.6 percent reduction between FY 1975 and FY 1978.

Energy usage by aircraft type is shown in Figure A-12. Only those aircraft types that used 100,000 barrels of fuel or more in FY 1975 are listed individually; those types that used less are included in the "other" category. Aircraft fuel usage declined 6.9 percent between FY 1975 and FY 1978.

Figure A-13 is a breakdown of aircraft petroleum usage by fuel type. As has been the case historically, JP-5 is the most used naval aircraft fuel. The large drop in JP-5 usage between FY 1975 and FY 1978 was offset to a degree by a significant increase in JP-4 usage. AVGAS usage continued to decline. During FY 1978, JP-5 provided 73.3 percent of naval aircraft fuel requirements; JP-4, 24.6 percent; and AVGAS, 2.2 percent. In FY 1975, the contributions were 83.5 percent, 11.7 percent, and 4.8 percent, respectively.

Figure A-14 illustrates the total flight hours by aircraft type. The detailed breakdown is the same as in Figure A-11. Total flight hours decreased 10.3 percent between FY 1975 and FY 1978. The calculated fuel usage rate per average flight hour is shown in Figure A-15. This overall average usage rate shows an increase of 3.4 percent. However, as with the ships, the overall usage rate does not present a true picture of aircraft performance. Figure A-16 compares energy usage at FY 1978 consumption rates with the usage which would have occurred had the aircraft operated FY 1978 hours at FY 1975 consumption rates. This comparison shows a net improvement in aircraft consumption of over 1.27 million barrels of petroleum, which is a decrease of 5.2 percent from FY 1978 hours at FY 1975 consumption rates.

Figure A-17 shows the savings resulting from substituting simulators for actual aircraft operations. The savings amounted to the equivalent of 5.7 percent of fuel used by aircraft in FY 1975 and 7.6 percent in FY 1978, or to an equivalent of 1.4 million barrels of oil in FY 1975, and 1.8 million barrels in FY 1978. The Navy's goal is a 9 percent savings by 1985 from simulator substitution.

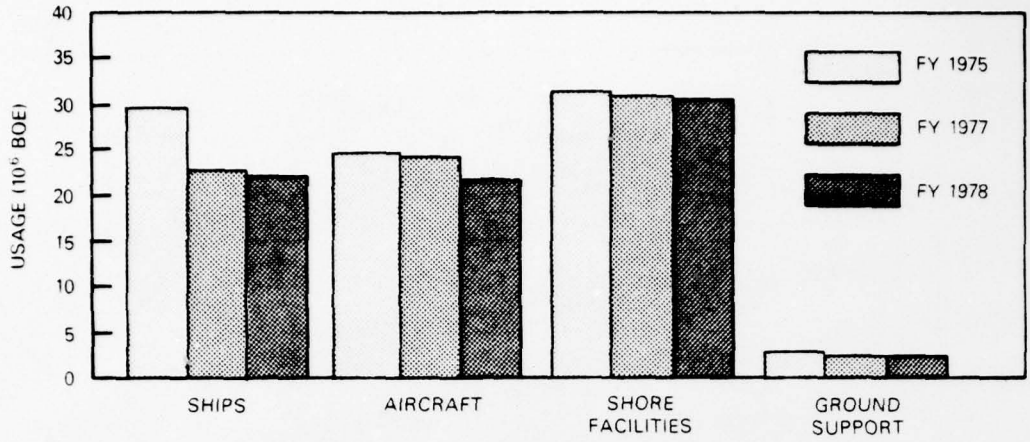
Figure A-18 illustrates shore facility energy usage, including cold iron support. There was a decrease of 1 million BOE between FY 1975 and FY 1978, representing a 3.1 percent reduction. Cold iron support increased from 2.7 million BOE in FY 1975 to 3.0 million BOE in FY 1978, a 13.3 percent increase. Thus, without cold iron support, shore facilities energy usage decreased 1.3 million BOE or 4.5 percent.

Energy usage per square foot of building area (not including cold iron support) is shown in Figure A-19. The decrease from FY 1975 to FY 1978 is from 48.2×10^{-3} BOE per square foot to 44.5×10^{-3} BOE per square foot, a decrease of 7.7 percent. The goal is a 20 percent reduction in energy usage per square foot by FY 1985.

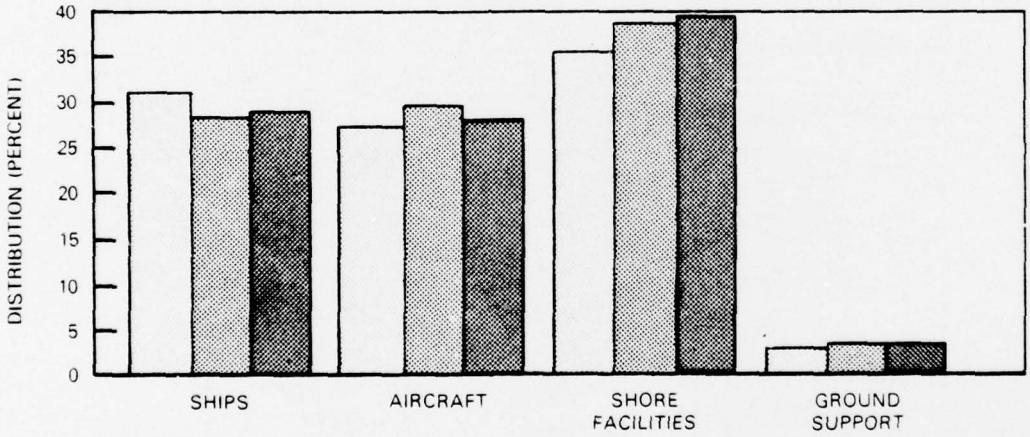
Figure A-20 shows ground vehicle energy usage. This usage decreased from 1.7 million BOE in FY 1975 to 1.5 million BOE in FY 1978, a decrease of 11.8 percent. A reduction of 15 percent by FY 1985 is the Navy's goal for ground vehicle usage.

Figure A-21 shows that coal and refuse-derived fuel (RDF) were substituted for 2.3 percent of the total petroleum and natural gas used by shore facilities during FY 1978. The goals for substitution are to obtain at least 10 percent of shore facilities energy from coal, coal gasification, RDF, and biomass by FY 1985, and to obtain at least 1 percent of shore facilities energy from solar and geothermal energy by FY 1985.

In summary, there has been a significant reduction in energy usage between FY 1975 and FY 1978. Although reducing operations has caused a large amount of this energy reduction, conservation efforts also have been effective. These conservation efforts are expected to increase appreciably during FY 1979 and, if adequate funding is provided, it is expected that all FY 1985 goals can be met.



ACTIVITY	ENERGY USAGE (10^6 BOE)			CHANGE (PERCENT)	
	FY 1975[a]	FY 1977	FY 1978	FY 1975-77	FY 1975-78
SHIPS	28.9[b]	23.6	23.3	−18.3	−19.4
AIRCRAFT	24.9	24.1	23.2	− 3.2	−6.8
[c]SHORE FACILITIES	32.6[b]	31.7	31.6	− 2.8	− 3.1
GROUND SUPPORT	2.7	2.5	2.5	− 7.4	− 7.4
TOTAL	89.1[b]	81.9	80.6	−8.1	−9.5



ACTIVITY	ENERGY USAGE DISTRIBUTION (PERCENT)		
	FY 1975[a]	FY 1977	FY 1978
SHIPS	32.4	28.8	28.9
AIRCRAFT	28.0	29.4	28.8
SHORE FACILITIES	36.6	38.7	39.2
GROUND SUPPORT	3.0	3.1	3.1

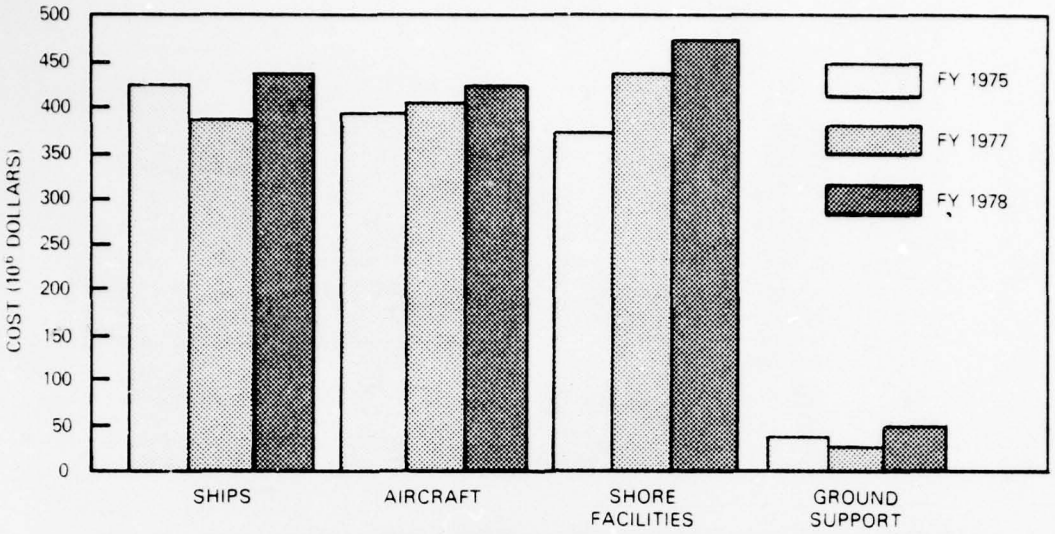
[a] Modified to cover 1 October through 30 September.

[b] Revised since 1978 Navy energy plan.

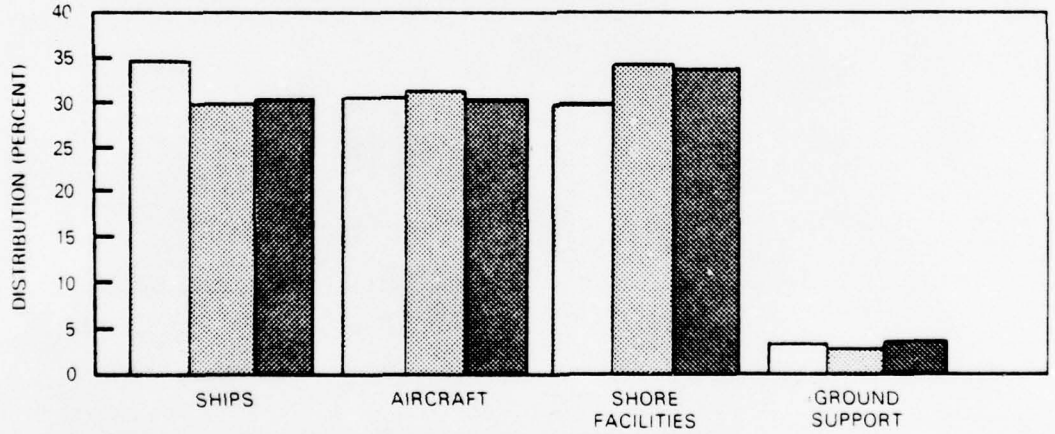
[c] Includes cold iron support (2.7 MBOE each in 1975 and 1977, 3.0 MBOE in 1978)

Sources: NEUPAS and NAVFAC III.

Figure A-1. ENERGY USAGE BY ACTIVITY



ACTIVITY	ENERGY COST (10^6 DOLLARS)			CHANGE (PERCENT)	
	FY 1975[a]	FY 1977	FY 1978	FY 1975-77	FY 1975-78
SHIPS	426.0	378.8	430.0	-11.1	+0.9
AIRCRAFT	390.2	403.7	426.7	- 3.5	- 9.4
SHORE FACILITIES	370.6	436.7	470.5	- 17.8	- 30.0
GROUND SUPPORT	42.8	36.8	50.1	- 14.0	- 17.1
TOTAL	1,229.6	1,256.0	1,377.3	+2.1	+12.0

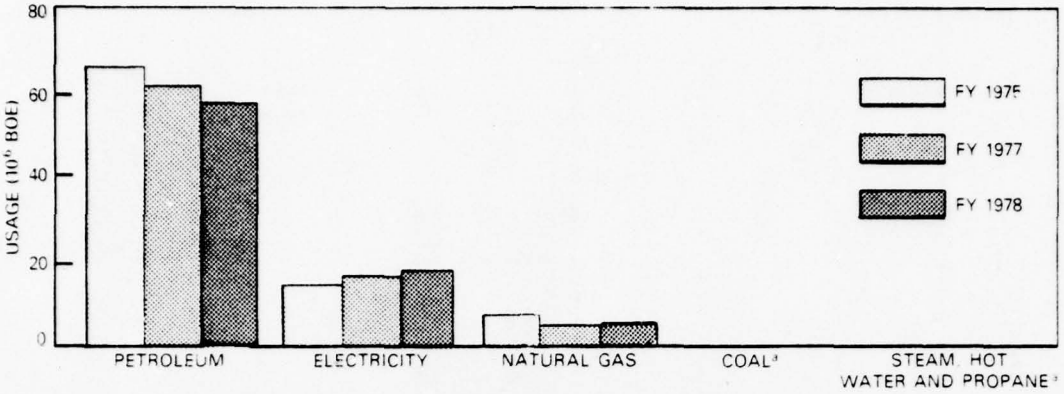


ACTIVITY	ENERGY COST DISTRIBUTION (PERCENT)		
	FY 1975[a]	FY 1977	FY 1978
SHIPS	34.7	30.2	31.2
AIRCRAFT	31.7	32.1	31.0
SHORE FACILITIES	30.1	34.8	34.2
GROUND SUPPORT	3.5	2.9	3.6

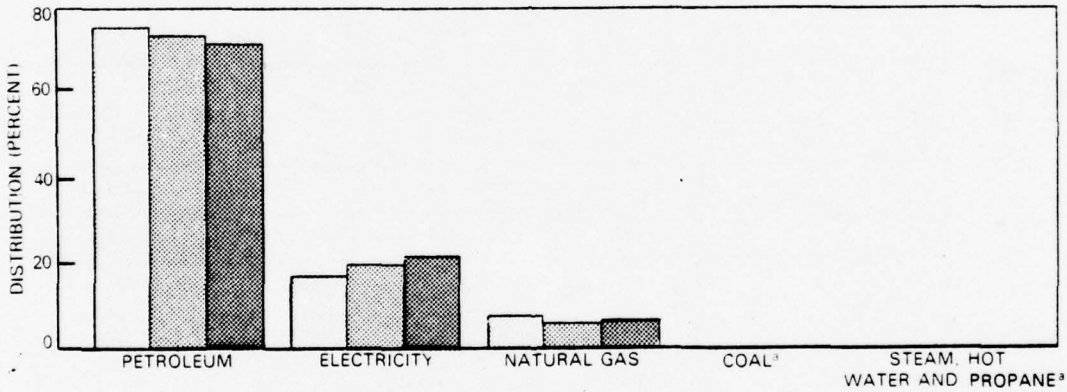
[a] Modified to cover 1 October through 30 September

Sources: OP-413 and NAVFAC III

Figure A-2. ENERGY COST BY ACTIVITY



ENERGY FORM	ENERGY USAGE (10^{15} BOE)			CHANGE (PERCENT)	
	FY 1975[b]	FY 1977	FY 1978	FY 1975-77	FY 1975-78
PETROLEUM	67.1	60.3	58.4	-10.1	-13.0
ELECTRICITY	16.2	16.8	17.2	+3.7	+6.2
NATURAL GAS	5.1	4.2	4.4	-17.6	-13.7
COAL	0.4	0.3	0.2	-25.0	-50.0
STEAM, HOT WATER, AND PROPANE	0.3	0.3	0.4	0	+33.3
TOTAL	89.1	81.9	80.6	-8.1	-9.5



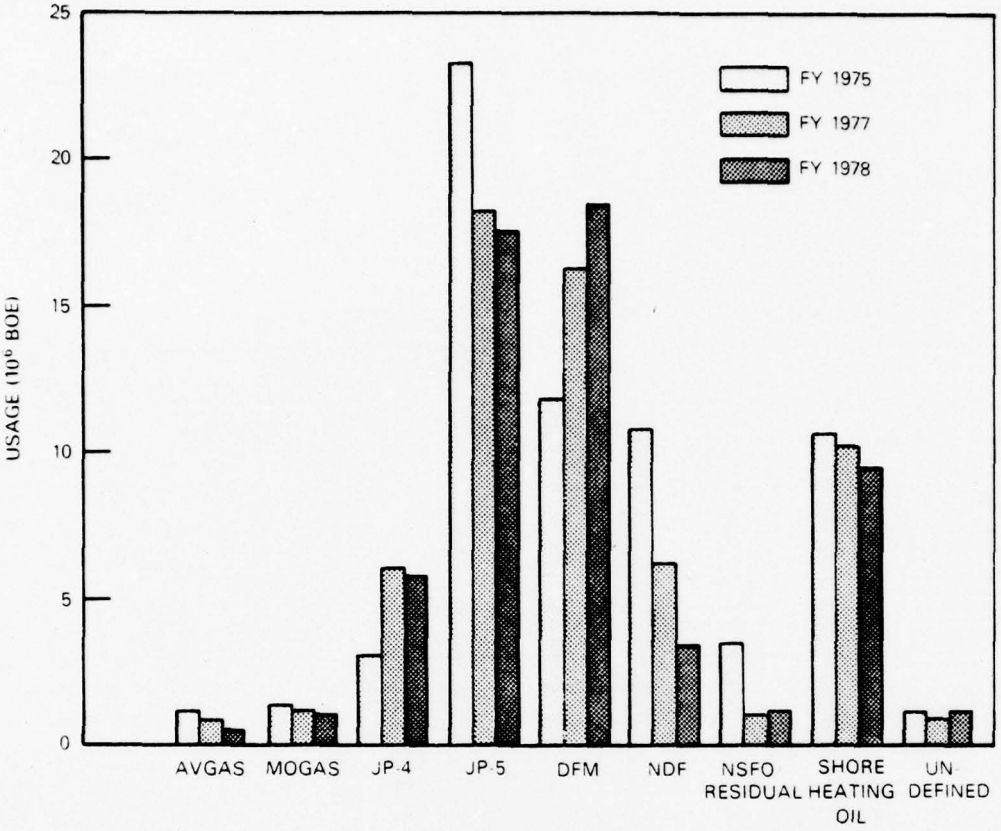
ENERGY FORM	ENERGY USAGE DISTRIBUTION (PERCENT)		
	FY 1975[b]	FY 1977	FY 1978
PETROLEUM	75.3	73.6	72.4
ELECTRICITY	18.2	20.5	21.4
NATURAL GAS	5.7	5.1	5.5
COAL	0.5	0.4	0.2
STEAM, HOT WATER, AND PROPANE	0.3	0.4	0.5

[a] Numbers too small for graphic representation.

[b] Modified to cover 1 October through 30 September.

Sources: NEUPAS and NAVFAC III.

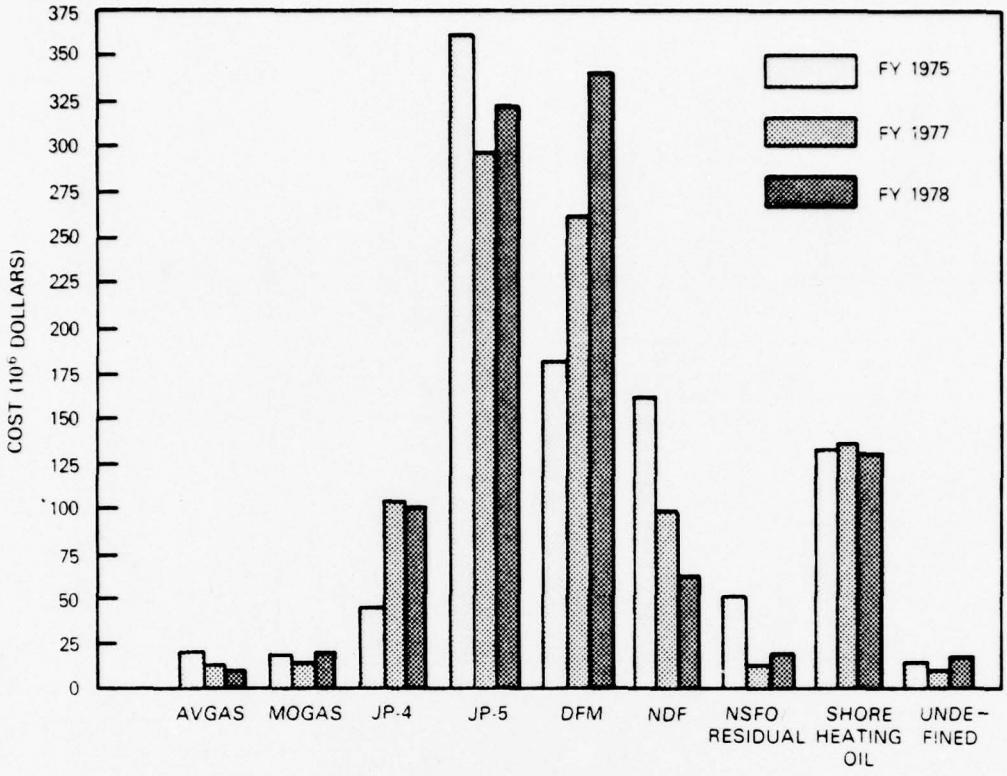
Figure A-3. ENERGY USAGE BY ENERGY FORM



FUEL TYPE	ENERGY USAGE (10^6 BOE)			CHANGE (PERCENT)	
	FY 1975[a]	FY 1977	FY 1978	FY 1975-77	FY 1975-78
AVGAS	1.2	0.7	0.5	-41.7	-58.3
MOGAS	1.3	1.2	1.0	-7.7	-23.1
JP-4	2.9	6.0	5.7	+106.9	+96.6
JP-5	23.3	18.3	17.6	-21.5	-24.9
DFM	12.3	16.1	18.6	+30.9	+51.2
NDF	10.8	6.1	3.4	-43.5	-68.5
NSFO RESIDUAL	3.7	1.0	1.1	-73.0	-70.3
SHORE HEATING OIL	10.6	10.1	9.4	-4.7	-11.3
UNDEFINED	1.0	0.8	1.1	-20.0	+10.0
TOTAL	67.1	60.3	58.4	-10.1	-13.0

[a] Modified to cover 1 October through 30 September.
Source: NEUPAS.

Figure A-4. ENERGY USAGE BY FUEL TYPE

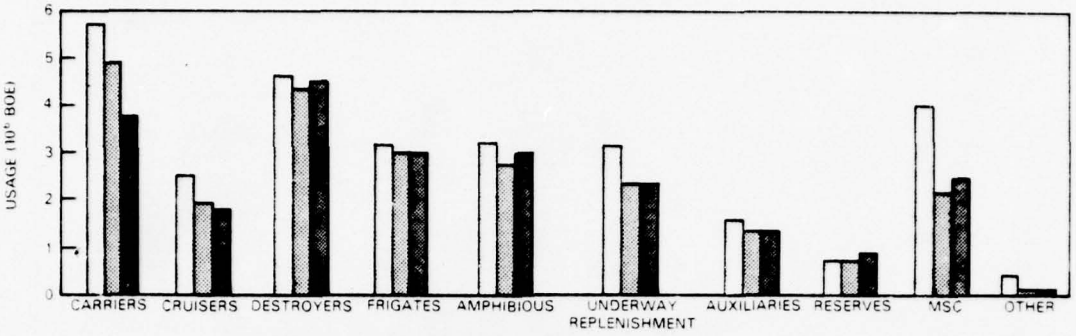


FUEL TYPE	ENERGY COST (10^6 DOLLARS)		
	FY 1975[a]	FY 1977	FY 1978
AVGAS	23.2	14.2	12.1
MOGAS	21.2	15.4	22.1
JP-4	47.5	108.4	100.4
JP-5	359.8	296.7	324.7
DFM	180.5	259.5	344.3
NDF	160.7	99.4	63.7
NSFO RESIDUAL	50.8	12.8	20.0
SHORE HEATING OIL	139.2	142.2	138.7
UNDEFINED	15.3	12.9	19.5
TOTAL	998.2	961.5	1,045.5

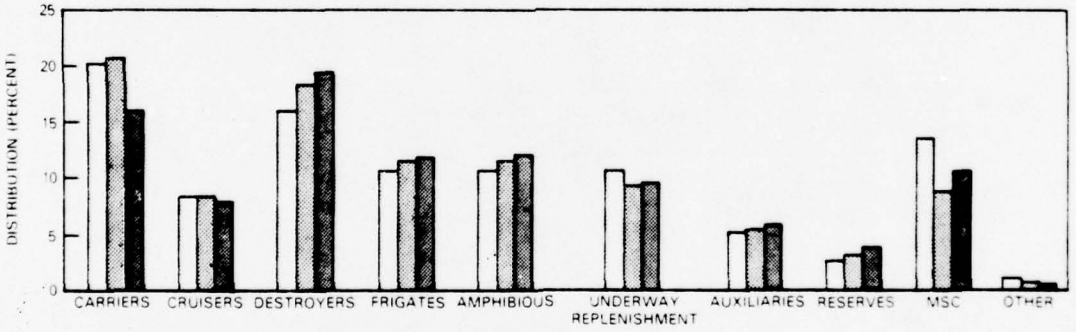
[a] Modified to cover 1 October through 30 September.

Source: OP-413

Figure A-5. ENERGY COST BY FUEL TYPE



SHIP CLASS	ENERGY USAGE (10^9 BOE)			CHANGE (PERCENT)	
	FY 1975[1]	FY 1977	FY 1978	FY 1975-77	FY 1975-78
CARRIERS	5.8	4.9	3.8	-15.5	-34.5
CRUISERS	2.4	1.9	1.8	-20.8	-25.0
DESTROYERS	4.6	4.3	4.5	-6.5	-2.2
FRIGATES	3.1	3.0	3.0	-3.2	-3.2
AMPHIBIOUS	3.2	2.8	3.0	-12.5	-6.3
UNDERWAY REPLENISHMENT	3.1	2.3	2.3	-25.8	-25.8
AUXILIARIES	1.6	1.4	1.4	-12.5	-12.5
RESERVES	0.8	0.8	0.9	0	+12.5
MSC	4.0	2.1	2.4	-47.5	-40.0
OTHER	0.3	0.1	0.1	-66.7	-66.7
TOTAL	28.9	23.6	23.2	-18.3	**-19.7**

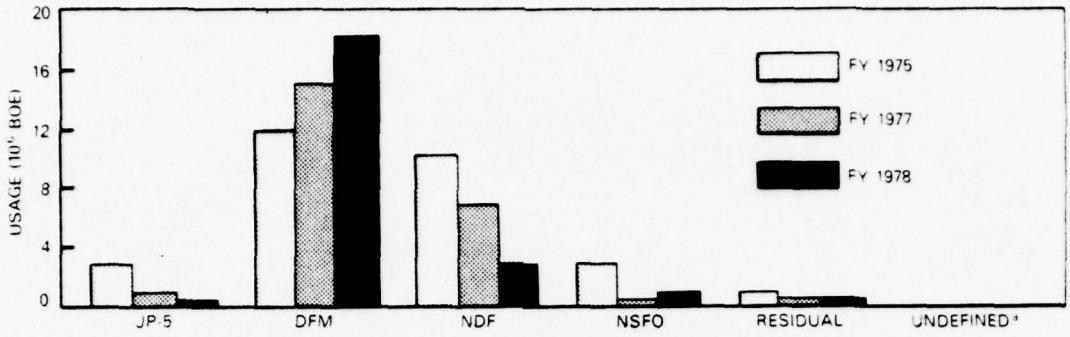


SHIP CLASS	ENERGY USAGE DISTRIBUTION (PERCENT)		
	FY 1975[1]	FY 1977	FY 1978
CARRIERS	20.1	20.9	16.4
CRUISERS	8.3	8.3	7.8
DESTROYERS	15.9	18.2	19.4
FRIGATES	10.7	12.6	12.9
AMPHIBIOUS	11.1	12.0	12.9
UNDERWAY REPLENISHMENT	10.7	9.6	9.9
AUXILIARIES	5.5	5.8	6.0
RESERVES	2.8	3.3	3.9
MSC	13.9	8.7	10.4
OTHER	1.0	0.6	0.4

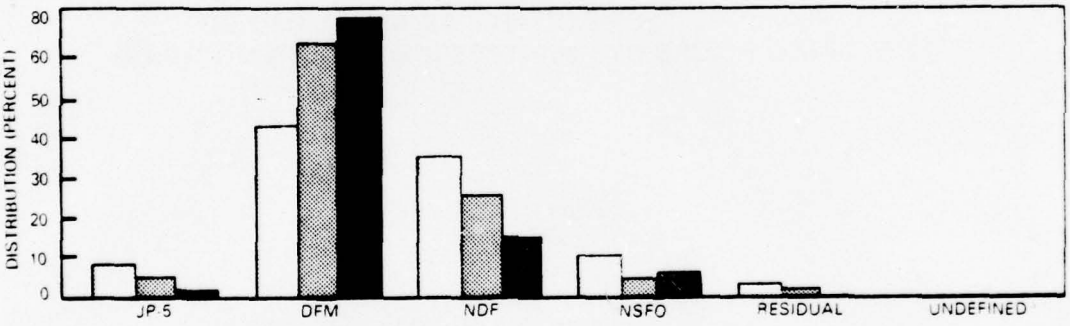
[1]Modified to cover 1 October through 30 September

Source: NEUPAS

Figure A-6. ENERGY USAGE BY SHIP CLASS (EXCEPT NUCLEAR)



FUEL TYPE	ENERGY USAGE (10^6 BOE)			CHANGE (PERCENT)	
	FY 1975[b]	FY 1977	FY 1978	FY 1975-77	FY 1975-78
JP-5	2.6	1.0	0.6	-61.5	-76.9
DFM	11.8	15.5	18.1	+31.4	+53.4
NDF	10.8	6.1	3.4	-43.5	-68.5
NSFO	2.9	0.9	1.1	-69.0	-62.1
RESIDUAL	0.8	0.1	< 0.1	-87.5	0
UNDEFINED	< 0.1	< 0.1	< 0.1	0	0
TOTAL	28.9	23.6	23.3	-18.3	-19.4



FUEL TYPE	ENERGY USAGE DISTRIBUTION (PERCENT)		
	FY 1975[b]	FY 1977	FY 1978
JP-5	9.0	4.2	2.6
DFM	40.8	65.7	78.0
NDF	37.4	25.8	14.7
NSFO	10.0	3.8	4.7
RESIDUAL	2.8	0.4	< 0.1
UNDEFINED	< 0.1	< 0.1	< 0.1

Numbers too small for graphic representation.
[b] Modified to cover 1 October through 30 September.
Source: NEUPAS

Figure A-7. SHIP ENERGY USAGE BY FUEL TYPE

SHIP TYPE	UNDERWAY STEAMING HOURS (10^3)			CHANGE (PERCENT)		NOT UNDERWAY STEAMING HOURS (10^3)			CHANGE (PERCENT)	
	FY 1975[a]	FY 1977	FY 1978	FY 1975-77	FY 1975-78	FY 1975	FY 1977	FY 1978	FY 1975-77	FY 1975-78
CARRIERS	43.8	34.5	27.2	-21.2	-37.9	29.7	24.8	19.1	-16.5	-35.7
CRUISERS	58.6	46.0	43.5	-21.5	-25.8	47.6	39.6	32.7	-16.8	-31.3
DESTROYERS	157.6	135.3	139.3	-14.1	-11.6	106.3	114.0	127.9	+7.2	-20.3
FRIGATES	145.5	135.5	142.9	-6.9	-1.8	64.8	76.1	74.1	-17.4	-14.4
AMPHIBIOUS	131.8	113.9	124.2	-13.6	-5.8	128.8	107.0	100.2	-16.9	-22.2
UNDERWAY REPLENISHMENT	119.1	78.7	81.3	-33.9	-31.7	112.5	80.0	75.7	-28.9	-32.7
AUXILIARIES	124.0[b]	104.3[b]	88.1[c]	-15.9	-30.0	182.3	157.3	132.8	-13.7	-27.2
RESERVES	56.1	49.7	58.9	-11.4	+5.0	69.7	63.5	54.7	-8.9	-21.5
MSC	—	—	—	—	—	—	—	—	—	—
OTHER	63.6	38.8	27.0	-39.0	-57.5	83.4	31.0	11.2	-62.8	-86.6
TOTAL	900.1	736.8	732.4	-18.1	-18.6	825.1	693.3	628.4	-16.0	-23.8

[a]Modified to cover 1 October through 30 September.
[b]Includes service ships.
[c]Includes 3 YTB service ships, but not 6 floating dry docks.
Source: NEUPAS.

Figure A-8. SHIP ACTIVITY AS MEASURED BY STEAMING HOURS BY SHIP TYPE (EXCLUDING NUCLEAR)

SHIP TYPE	NUMBER OF SHIPS (END OF FISCAL YEAR)			FUEL CONSUMPTION PER UNDERWAY STEAMING HOUR (Bbl/HR)			CHANGE (PERCENT)	
	FY 1975[a]	FY 1977	FY 1978	FY 1975	FY 1977	FY 1978	FY 1975-77	FY 1975-78
CARRIERS	13	10	10	118.2	121.0	116.6	+2.4	-1.4
CRUISERS	22	20	20	33.3	33.5	33.6	+0.6	+0.9
DESTROYERS	70	64	67	23.9	25.5	25.9	+6.7	+8.4
FRIGATES	64	64	65	17.9	18.8	17.9	+5.0	0
AMPHIBIOUS	64	62	63	18.4	18.5	18.2	+.5	-1.1
UNDERWAY REPLENISHMENT	43	39	37	21.3	22.7	22.1	+6.6	+3.8
AUXILIARIES	78[b]	67[b]	60[c]	5.7	6.5	9.6	+14.0	+68.4
RESERVES	63	59	58	11.5	12.3	12.0	+7.0	+4.3
SUBMARINES	10	10	9	2.5	2.7	2.4	+8.0	-4.0
PATROL COMBATANT AND MINE WARFARE	17	10	6	2.0	2.1	3.1	+5.0	+55.0
TOTAL	444	405	395	22.1	23.0	22.5	+4.1	+1.8

[a]Modified to cover 1 October through 30 September.
[b]Includes service ships.
[c]Includes 3 YTB service ships, but not 6 floating dry docks.

FUEL CONSUMPTION PER NOT UNDERWAY STEAMING HOUR (BBL/HR)			CHANGE (PERCENT)	
FY 1975	FY 1977	FY 1978	FY 1975-77	FY 1975-78
5.7	6.5	6.8	+14.0	+19.3

SOURCE: NEUPAS

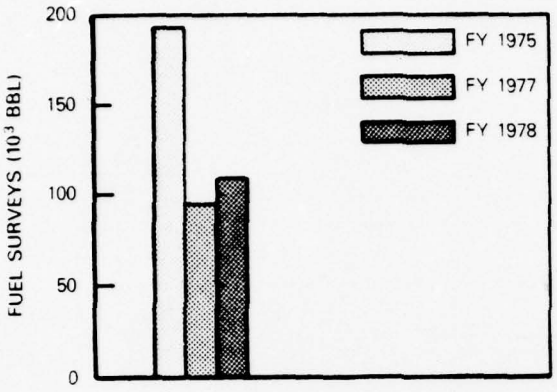
Figure A-9. FUEL CONSUMPTION PER STEAMING HOUR BY SHIP TYPE (EXCLUDING NUCLEAR AND MSC)

SHIP CLASS	TOTAL UNDERWAY CONSUMPTION (Bbl) FY 1975[a]	UNDERWAY CONSUMPTION RATE (Bbl/HR) FY 1975	TOTAL UNDERWAY CONSUMPTION (Bbl) FY 1978	UNDERWAY STEAMING (HOURS) FY 1978	UNDERWAY CONSUMPTION RATE (Bbl/HR) FY 1978	TOTAL UNDERWAY CONSUMPTION FY 1978 HOURS AT FY 1975 RATES (Bbl)	CHANGE (Bbl) (COL 3-COL 6)	CHANGE (PERCENT) (COL 3-COL 6)
FF 1052	2,018,970	18.4	1,815,345	101,041	18.0	1,859,154	43,809	2.4
DDG 2	1,111,102	23.8	1,181,161	48,351	24.4	1,150,754	- 30,407	- 2.6
CV 59	1,814,599	131.1	1,119,991	9,353	119.7	1,226,178	- 106,187	- 8.7
CV 63	890,050	122.3	1,020,749	8,832	115.6	1,080,154	- 59,405	- 5.5
DD 963[b]	—	—	761,366	26,219	29.0	—	—	—
CV 41	1,593,364	122.5	663,155	5,659	117.2	693,228	- 30,073	- 4.3
FRAM I	1,698,427	19.6	704,036	36,114	19.5	707,834	- 3,798	- 0.5
DDG 37	526,848	31.2	589,475	17,725	33.3	553,020	- 36,455	- 6.6
DD 931	396,102	21.0	577,236	26,366	21.9	553,686	- 23,550	- 4.3
CG 16	747,130	30.9	563,996	18,748	30.1	579,313	- 15,317	- 2.6
LPD 4	721,093	25.4	530,899	21,328	24.9	541,731	- 10,832	- 2.0
CG 26	691,751	29.6	515,152	17,090	30.1	505,864	- 9,288	- 1.8
LST 1179	417,621	10.0	433,721	41,283	10.5	412,830	- 20,891	- 5.1
AOE 1	481,241	41.8	425,491	11,616	36.6	485,549	- 60,058	- 12.4
AOR 1	377,605	22.7	387,793	16,037	24.2	364,040	- 23,753	- 6.5
FF 1040	322,400	20.0	372,450	19,317	19.3	386,340	- 13,890	- 3.6
CV 67	242,894	94.7	368,100	3,385	108.7	320,560	- 47,540	- 14.8
LPH 2	323,332	21.6	362,264	17,975	20.2	388,260	- 25,996	- 6.7
LSD 28	279,759	20.5	291,391	12,471	23.4	255,656	- 35,735	- 13.9
FFG 1	210,974	17.0	263,947	14,665	18.0	249,305	- 14,642	- 5.9
LSD 36	212,429	21.8	255,007	11,866	21.5	258,679	- 3,672	- 1.4
CG 10	247,614	46.1	246,031	4,876	50.5	224,784	- 21,247	- 9.5
AFS 1	351,976	18.4	243,381	14,239	17.1	261,998	- 18,617	- 7.1
AE 26	404,331	19.1	239,727	13,248	18.1	253,037	- 13,310	- 5.3
AO 143	301,607	25.1	238,606	8,424	28.3	211,442	+ 27,164	+ 12.8
DDG 31	243,216	27.5	185,303	7,287	25.4	200,393	- 15,090	- 7.5
CVT 16	285,076	101.6	154,435	1,766	87.4	179,426	- 24,991	- 13.9
DD 945	294,134	31.4	149,335	6,574	22.8	206,424	- 57,089	- 27.7
AO 51	90,981	17.6	143,291	8,794	16.3	154,774	- 11,483	- 7.4
CG 4[b]	—	—	135,657	2,826	48.0	—	—	—
LCC 19	125,159	26.0	117,562	5,721	20.5	148,746	- 31,184	- 21.0
LKA 113	156,344	19.1	116,969	7,539	15.5	143,995	- 27,026	- 18.8
AD 14	124,286	26.4	104,219	4,239	24.6	111,910	- 7,691	- 6.9
AE 23	124,422	14.8	85,903	6,433	13.4	95,208	- 9,305	- 9.8
FF 1037	39,444	8.2	83,476	6,402	13.0	52,496	+ 30,980	+ 59.0
LPD 1	89,372	21.1	78,695	4,063	19.4	85,729	- 7,034	- 8.2
LHA 1[b]	—	—	78,514	1,956	40.1	—	—	—
AGF 3	57,777	19.9	70,869	3,265	21.7	64,974	+ 5,895	+ 9.1
AGFF 1	44,579	19.7	62,615	3,499	17.9	68,930	- 6,315	- 9.2
AD 37	30,729	23.9	60,628	2,174	27.9	51,949	+ 8,669	+ 16.7
AR 5	78,879	20.8	57,693	2,763	20.9	57,470	+ 223	+ 0.4
DDG 41[b]	—	—	55,222	1,623	34.0	—	—	—
DDG 35	64,755	25.9	38,218	1,281	29.8	33,178	+ 5,040	+ 15.2
ATF 96	51,477	2.4	35,064	16,182	2.2	38,837	- 3,773	- 9.7
AGDS 2[b]	—	—	32,559	2,705	12.0	—	—	—
AG 153	27,041	11.8	31,378	2,956	10.6	34,881	- 3,503	- 10.0
AS 31	10,304	12.5	30,253	1,662	18.2	20,775	+ 9,478	+ 45.6
ARS 38	36,832	3.0	30,141	10,747	2.8	32,241	- 2,100	- 6.5
AE 21	38,098	13.8	29,836	2,547	11.7	35,149	- 5,313	- 15.1
MSO 422	26,135	1.4	26,969	17,854	1.5	24,996	+ 1,973	+ 7.9
ARS 6	32,531	2.5	25,477	8,820	2.9	22,050	+ 3,427	+ 15.5
FFG 7[b]	—	—	25,077	1,456	17.2	—	—	—
AS 33	3,190	21.0	24,270	892	27.2	18,732	+ 5,538	+ 29.6
AO 26	6,609	13.7	19,527	1,180	16.5	16,166	+ 3,361	+ 20.8
ATF 148	41,197	2.7	19,232	7,700	2.5	20,790	- 1,558	- 7.5
ATS 1	19,690	4.1	17,588	4,751	3.7	19,479	- 1,921	- 9.9
AS 36	13,141	25.3	17,401	910	19.1	23,023	- 5,622	- 24.4
SS 563	16,135	2.7	17,283	5,980	2.9	16,146	+ 1,137	+ 7.0
LPA 248	28,248	14.1	17,365	1,008	17.2	14,213	+ 3,152	+ 22.2
AVM 1	14,667	13.7	14,845	1,093	13.6	14,974	- 129	- 0.9
ASR 7	26,607	2.4	13,078	5,570	2.3	13,368	- 290	- 2.2
LKA 112	50,402	18.9	14,059	894	15.7	16,897	- 2,838	- 16.8
AS 11	7,367	6.7	12,929	1,369	9.4	9,172	+ 3,797	+ 41.4
SS 580	8,977	1.9	13,557	6,171	2.2	11,725	+ 1,832	+ 15.6
PHM 1[b]	—	—	12,868	1,503	8.6	—	—	—
ASR 21	9,650	4.2	11,785	3,150	3.7	13,230	- 1,445	- 10.9
OTHER	77,341	2.5	27,831	13,577	2.0	33,943	- 6,112	- 18.0
TOTAL	18,778,011		16,469,446			15,471,193	261,602	1.7

[a]Modified to cover 1 October through 30 September.
[b]Ships not in 1975 fleet.

Sources: NEUPAS and OP-413.

Figure A-10. SHIP UNDERWAY CONSUMPTION BY SELECTED SHIP CLASS



FUEL SURVEYS (10^3 BBL)			CHANGE (PERCENT)	
FY 1975[a]	FY 1977	FY 1978	FY 1975-77	FY 1975-78
193.0	96.5	116.5	-50.0	-39.6

[a] Modified to cover 1 October through 30 September.

Note: The Navy's goal is to achieve a 90 percent reduction in fleet surveys by 1985.

Source: NAVPETOFF Fuel Survey Reports.

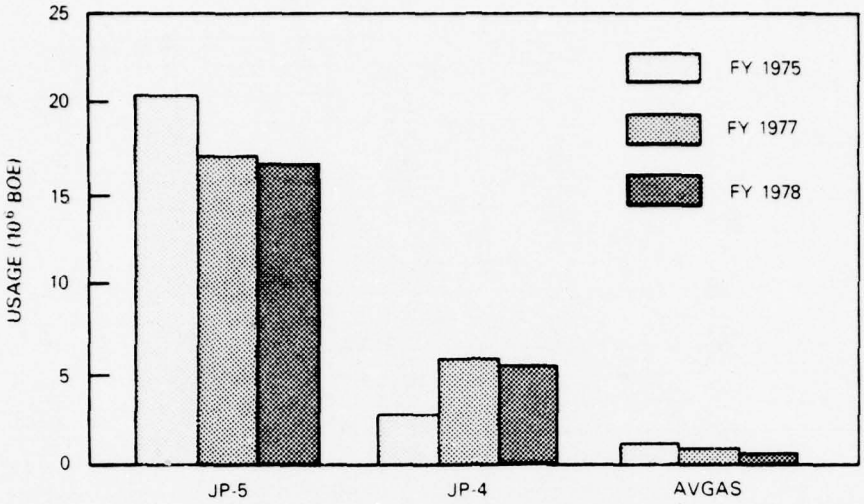
Figure A-11. FUEL SURVEYS

AIRCRAFT TYPE	ENERGY USAGE (10^3 BOE))			CHANGE (PERCENT)		ENERGY USAGE (PERCENT)		
	FY 1975[a]	FY 1977	FY 1978	FY 1975-77	FY 1975-78	FY 1975	FY 1977	FY 1978
A-4	1,334	774	720	-42.0	-46.0	5.4	3.2	3.1
A-6	1,679	1,643	1,895	-2.1	+12.9	6.7	6.8	8.2
A-7	2,576	2,520	2,391	-2.2	-7.2	10.3	10.5	10.3
AV-8	220	190	192	-13.6	-12.7	0.9	0.8	0.8
C-1	155	77	60	-50.3	-61.3	0.6	0.3	0.3
C-9	352	401	431	+13.9	+22.4	1.4	1.7	1.9
C-118	292	220	171	-24.7	-41.4	1.2	0.9	0.7
CH-46	293	274	266	-6.5	-9.2	1.2	1.1	1.1
CH-53	222	246	257	+10.8	+15.8	0.9	1.0	1.1
CT-39	136	106	157	-22.1	+15.4	0.5	0.4	0.7
E-2	178	249	367	+39.9	+106.2	0.7	1.0	1.6
EA-3	163	111	92	-31.9	-43.6	0.7	0.5	0.4
EA-6	414	531	560	+28.3	+35.3	1.7	2.2	2.4
EC-130	245	269	247	+9.8	+0.8	1.0	1.1	1.1
EP-3	149	165	134	+10.7	-10.1	0.6	0.7	0.6
F-4	4,710	4,251	4,043	-9.7	-14.2	18.9	17.6	17.4
F-8	546	0	0	-100.0	-100.0	2.2	0	0
F-14	554	1,300	1,403	+134.7	+153.2	2.2	5.4	6.1
KH-3	107	142	92	+32.7	-14.0	0.4	0.6	0.4
KH-6	318	395	377	+24.2	+18.6	1.3	1.6	1.6
KC-130	456	458	478	+0.4	+4.8	1.8	1.9	2.1
P-3	3,965	4,181	3,812	+5.4	-3.9	15.9	17.4	16.4
RH-5	297	262	197	-11.8	-33.7	1.2	1.1	0.9
RF-4	189	181	151	-4.2	-20.1	0.8	0.8	0.7
RF-8	132	118	134	-10.6	+1.5	0.5	0.5	0.6
S-3	123	503	559	+308.9	+354.5	0.5	2.1	2.4
SH-3	261	253	236	-3.1	-9.6	1.0	1.1	1.0
SP-2	125	6	0	-95.2	-100.0	0.5	0	0
T-2	677	839	665	+23.9	-1.8	2.7	3.5	2.9
T-28	219	190	105	-13.2	-52.1	0.9	0.8	0.5
T-39	132	222	139	+68.1	+5.3	0.5	0.9	0.6
TA-4	1,965	1,728	1,586	-12.1	-19.2	7.9	7.2	6.8
UH-1	106	130	99	+22.6	-6.6	0.4	0.5	0.4
US-2	107	34	25	-68.2	-76.6	0.4	0.1	0.1
OTHER	1,495	1,116	1,135	-25.4	-24.1	6.0	4.6	4.9
TOTAL	24,892	24,085	23,176	-3.2	-6.9			

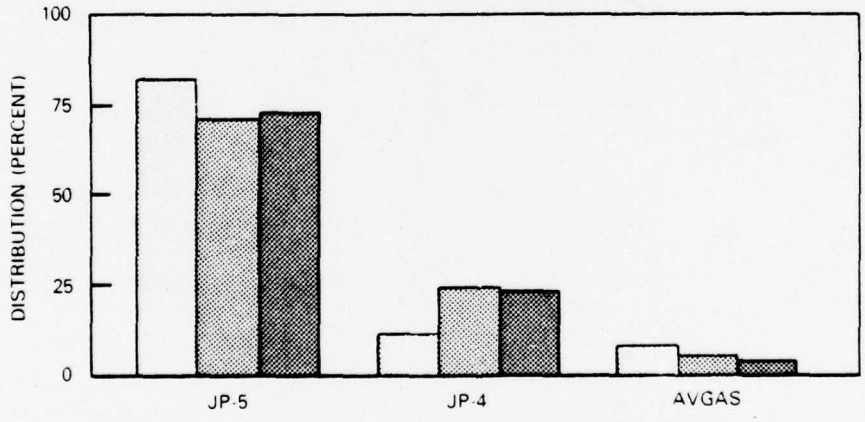
[a]Modified to cover 1 October through 30 September.

Source: NEUPAS.

Figure A-12. ENERGY USAGE BY AIRCRAFT TYPE



FUEL TYPE	ENERGY USAGE (10^6 BOE)			CHANGE (PERCENT)	
	FY 1975[a]	FY 1977	FY 1978	FY 1975-77	FY 1975-78
JP-5	20.8	17.4	17.0	-13.9	-18.3
JP-4	2.9	6.0	5.7	+106.9	+96.6
AVGAS	1.2	0.7	0.5	-41.7	-58.3
TOTAL	24.9	24.1	23.2	-3.2	-6.9



FUEL TYPE	ENERGY USAGE DISTRIBUTION (PERCENT)		
	FY 1975[a]	FY 1977	FY 1978
JP-5	83.5	72.2	73.3
JP-4	11.7	24.9	24.6
AVGAS	4.8	2.9	2.2

[a] Modified to cover 1 October through 30 September.

Source: NEUPAS.

Figure A-13. AIRCRAFT ENERGY USAGE BY FUEL TYPE

AIRCRAFT TYPE	FLIGHT HOURS (10^3)			CHANGE (PERCENT)	
	FY 1975[a]	FY 1977	FY 1978	FY 1975-77	FY 1975-78
A-4	95.0	65.0	60.5	-31.6	-36.3
A-6	70.2	73.9	83.2	+5.3	+18.5
A-7	187.6	185.7	183.4	-1.0	-2.2
AV-8	13.0	13.5	13.6	+3.8	+4.6
C-1	30.3	26.0	26.3	-14.2	-13.2
C-9	16.0	21.0	19.9	+31.3	+24.4
C-118	29.5	22.4	19.3	-24.1	-34.6
CH-46	75.7	78.7	75.6	+4.2	-0.1
CH-53	33.3	42.9	42.2	+28.8	+26.7
CT-39	14.9	17.4	18.8	+16.8	+26.2
E-2	18.7	27.8	30.9	+48.7	+65.2
EA-3	5.6	4.4	3.9	-21.4	-30.4
EA-6	17.3	23.6	25.0	+36.4	+44.5
EC-130	14.8	16.2	14.8	+9.5	0
EP-3	8.6	10.2	9.8	+18.6	+14.0
F-4	133.9	126.5	121.8	-5.5	-9.0
F-8	27.3	0	0	-100.0	-100.0
F-14	19.4	47.6	52.5	+145.4	+170.6
KA-3	4.6	5.8	3.9	+26.1	-15.2
KA-6	13.3	15.7	15.6	+18.0	+17.3
KC-130	24.6	26.8	25.3	+8.9	+2.8
P-3	225.5	238.7	236.2	+5.9	+4.7
RA-5	8.7	8.2	6.4	-5.7	+26.4
RF-4	5.4	5.6	4.4	+3.7	-18.5
RF-8	7.2	7.7	7.7	+6.9	+6.9
S-3	13.0	57.9	63.3	+345.4	+386.9
SH-3	70.1	74.2	70.6	+5.8	+0.7
SP-2	12.3	0.6	0	-95.1	-100.0
T-2	95.6	92.1	74.3	-3.7	-22.3
T-28	162.1	137.0	80.8	-15.5	-50.2
T-39	16.4	14.7	16.2	-10.4	-1.2
TA-4	166.0	148.1	138.1	-10.8	-16.8
UH-1	52.2	54.0	51.0	+3.4	-2.3
US-2	39.7	17.0	13.4	-57.2	-66.2
OTHER	388.3	263.5	288.4	-32.1	-25.7
TOTAL	2,116.1	1,970.4	1,897.1	-6.9	-10.3

[a] Modified to cover 1 October through 30 September.
Source: NEUPAS.

Figure A-14. AIRCRAFT ACTIVITY AS MEASURED BY FLIGHT HOURS BY AIRCRAFT TYPE

AIRCRAFT TYPE	NUMBER OF AIRCRAFT			CHANGE (PERCENT)		ENERGY USAGE RATE (Bbl/HR)			CHANGE (PERCENT)		
	FY 1975[a]	FY 1977	FY 1978	FY 1975-77	FY 1975-78	FY 1975	FY 1977	FY 1978	FY 1975-77	FY 1975-78	FY 1977-78
A-4	284	249	269	-12.3	-5.3	14.0	11.9	11.9	-15.0	-15.0	0
A-6	218	248	243	+13.8	-11.5	23.9	22.2	22.8	-7.1	-4.6	+2.7
A-7	442	488	406	+10.4	-8.1	13.7	13.6	13.0	-0.7	-5.1	-4.4
AV-8	61	67	63	+9.8	+3.3	16.9	14.1	14.2	-16.6	-16.0	+0.7
C-1	56	59	57	+5.4	+1.8	5.1	2.9	2.3	-43.1	-54.9	-20.7
C-9	8	14	13	+75.0	+62.5	22.0	19.0	21.6	-13.6	-1.8	+13.7
C-118	39	42	34	+7.7	-12.8	9.9	9.8	8.9	-1.0	-10.1	-9.2
CH-46	225	277	274	+23.1	+21.8	3.9	3.5	3.5	-10.3	-10.3	0
CH-53	146	152	140	+4.1	-4.1	6.7	5.7	6.1	-14.9	-9.0	+7.0
CT-39	12	16	17	+33.3	+41.7	9.1	6.1	8.3	-33.0	-8.8	+36.1
E-2	40	64	66	+60.0	+65.0	9.6	8.9	11.9	-7.3	+24.0	+33.7
EA-3	9	14	13	+55.6	+44.4	29.2	25.1	23.7	-14.0	-18.8	-5.6
EA-6	52	61	59	+17.3	+13.5	24.0	22.5	22.4	-6.3	-6.7	-0.4
EC-130	9	10	10	+11.1	+11.1	16.5	16.6	16.7	+0.6	+1.2	+0.6
EP-3	9	13	12	+44.4	+33.3	17.3	16.2	13.6	-6.4	-21.4	-16.0
F-4	410	486	406	+18.5	-1.0	35.2	33.6	33.2	-4.5	-5.7	-1.2
F-8	103	0	0	-100.0	-100.0	20.0	—	—	—	—	—
F-14	66	189	198	+186.4	+200.0	28.6	27.3	26.7	-4.5	-6.6	-2.2
KA-3	10	14	13	+40.0	+30.0	23.4	24.8	23.8	+6.0	+1.7	-4.0
KA-6	44	55	47	+25.0	+6.8	24.0	25.2	24.2	+5.0	+0.8	-4.0
KC-130	31	47	46	+51.6	+48.4	18.6	17.1	18.9	-8.1	+1.6	+10.5
P-3	308	368	349	+19.5	+13.3	17.6	17.5	16.1	-0.6	-8.5	-8.0
RA-5	26	25	17	-3.8	-34.6	34.0	31.9	30.6	-6.2	-10.0	-4.1
RF-4	21	22	20	+4.8	-4.8	34.8	32.3	34.5	-7.2	-0.9	+6.8
RF-8	23	26	24	+13.0	+4.3	18.2	15.3	17.5	-15.9	-3.8	+14.4
S-3	37	146	154	+294.6	+316.2	9.5	8.7	8.8	-8.4	-7.4	+1.1
SH-3	172	180	171	+4.7	+0.6	3.7	3.4	3.3	-8.1	-10.8	-2.9
SP-2	38	9	0	-76.3	-100.0	10.2	9.0	—	-11.8	—	—
T-2	232	201	186	+13.4	+19.8	7.1	9.1	9.0	+28.2	+26.8	-1.1
T-28	273	257	205	-5.9	-24.9	1.3	1.4	1.3	+7.7	0	-7.1
T-39	28	35	35	+25.0	+25.0	8.0	15.1	8.6	+88.8	+7.5	-43.0
TA-4	349	356	348	+2.0	+0.3	11.8	11.7	11.5	-0.8	-2.5	-1.7
UH-1	156	177	182	+13.5	+16.7	2.0	2.4	2.0	+20.0	0	-16.7
US-2	116	70	56	-39.7	-51.7	2.7	2.0	1.9	-25.9	-29.6	-5.0
OTHER	961	676	733	-29.7	-23.7	3.9	4.2	3.9	+7.7	0	-7.1
TOTAL	5,014	5,113	4,866	+2.0	+3.0	11.8	12.2	12.2	+3.4	+3.4	0

[a]Modified to cover 1 October through 30 September.

Note: The Navy's goal is to reduce fossil fuel energy per flight hour 5 percent by 1985.

Source: NEUPAS.

Figure A-15. ENERGY USAGE PER FLIGHT HOUR BY AIRCRAFT

AIRCRAFT TYPE	FY 1975 TOTAL CONSUMPTION (10^3 Bbl) FY 1975[a]	CONSUMPTION RATE FY 1975 (Bbl/HR) FY 1975	FY 1978 TOTAL CONSUMPTION (10^3 Bbl) FY 1978	FY 1978 FLIGHT HOURS (10^3 HRS) FY 1978	CONSUMPTION RATE FY 1978 (Bbl/HR) FY 1978	CONSUMPTION FY 1978 HOURS AT FY 1975 RATE (10^3 Bbl)	CHANGE (10^3 Bbl) (COL 3-COL 6)	CHANGE (PERCENT) (COL 3-COL 6)
F-4	4,710	35.2	4,043	121.8	33.2	4,287	-244	-5.7
P-3	3,965	17.6	3,812	236.2	16.1	4,157	-343	-8.3
A-7	2,576	13.7	2,391	183.4	13.0	2,513	-122	-4.9
A-6	1,679	23.9	1,895	83.2	23.8	1,988	-93	-4.7
TA-4	1,965	11.8	1,586	138.1	11.5	1,630	-44	-2.7
F-14	554	28.6	1,403	52.5	26.7	1,502	-99	-6.6
A-4	1,334	14.0	720	60.5	11.9	847	-127	-15.0
T-2	677	7.1	665	74.3	9.0	528	-137	-25.9
EA-6	414	24.0	560	25.0	22.4	600	-40	-6.7
S-3	123	9.5	559	63.3	8.8	601	-42	-7.0
KC-130	456	18.6	478	25.3	18.9	471	-7	-1.5
C-9	352	22.0	431	19.9	21.6	438	-7	-1.6
E-2	178	9.6	367	30.9	11.9	297	-70	-23.6
KA-6	318	24.0	377	15.6	24.2	374	-3	-0.1
CH-46	293	3.9	266	75.6	3.5	295	-29	-9.8
CH-53	222	6.7	257	42.2	6.1	283	-26	-9.2
EC-130	245	16.5	247	14.8	16.7	244	-3	-1.2
SH-3	261	3.7	236	70.6	3.3	261	-25	-9.6
RA-5	297	34.0	197	6.4	30.6	218	-21	-9.6
AV-8	220	16.9	192	13.6	14.2	230	-38	-1.7
C-118	292	9.9	171	19.3	8.9	191	-20	-10.5
CT-39	136	9.1	157	18.8	8.3	171	-14	-8.2
RF-4	189	34.8	151	4.4	34.5	153	-2	-1.3
EP-3	149	17.3	134	9.8	13.6	170	-36	-21.2
RF-8	132	18.2	134	7.7	17.5	140	-6	-4.3
T-39	132	8.0	139	16.2	8.6	130	-9	-6.9
T-28	219	1.3	105	80.8	1.3	105	—	—
EA-3	163	29.2	92	4.9	24.5	143	-51	-35.7
KA-3	107	23.4	92	3.9	23.8	91	-1	-1.1
UH-1	106	2.0	99	51.0	2.0	102	-3	-2.9
C-1	155	5.1	60	26.3	2.3	134	-74	-55.2
US-2	107	2.7	25	13.4	1.9	36	-11	-30.6
OTHER	1,495	3.9	1,135	288.4	3.9	1,125	-10	-0.9
TOTAL	24,221		23,176			24,455	1,277	-5.2

[a]Modified to cover 1 October through 30 September.

Sources: NEUPAS and OP-413

Figure A-16. AIRCRAFT CONSUMPTION BY AIRCRAFT TYPE

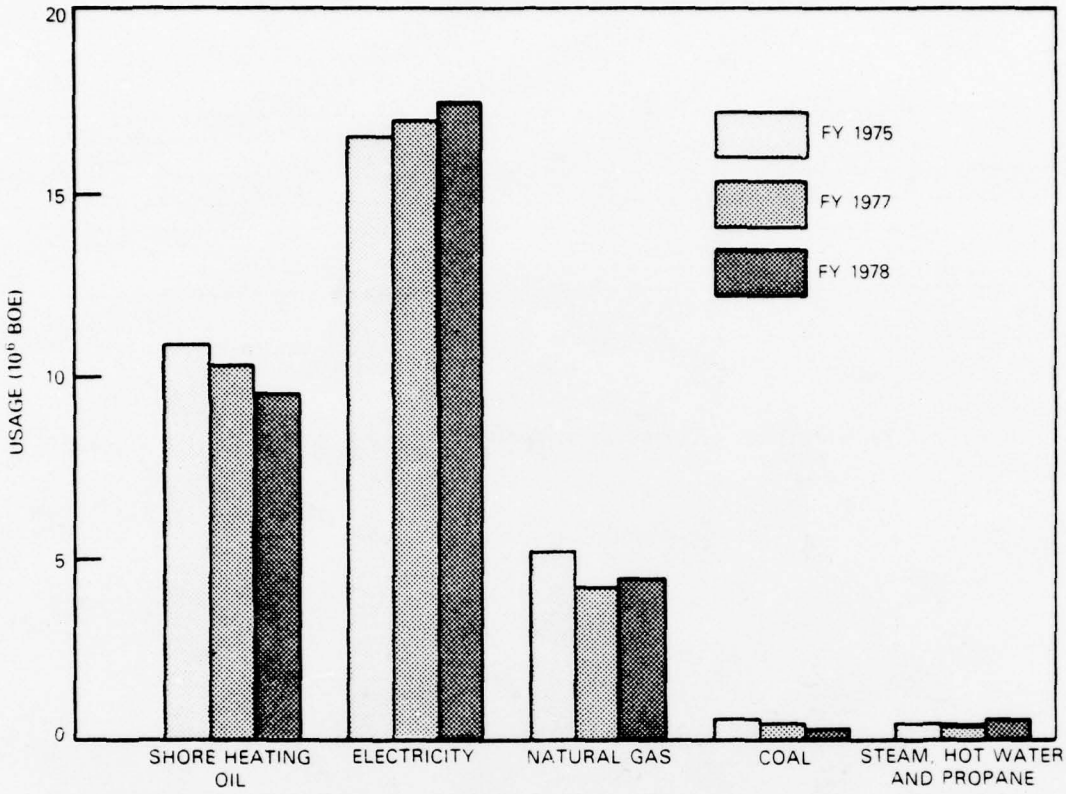
ENERGY SAVINGS (10^3 BBL)			CHANGE (PERCENT)		PERCENT OF AIRCRAFT ENERGY USAGE			CHANGE (PERCENT)	
FY 1975[a]	FY 1977	FY 1978	FY 1975-77	FY 1975-78	FY 1975[a]	FY 1977	FY 1978	FY 1975-77	FY 1975-78
1,430	1,770	1,770	- 23.7	- 23.7	5.7	7.3	7.6	- 28.1	- 33.3

[a]Modified to cover 1 October through 30 September.

Note: The Navy's goal is 9 percent energy savings per year by 1985.

Source: OP-59C

Figure A-17. ENERGY SAVED BY AIRCRAFT SIMULATOR SUBSTITUTION



ENERGY FORM	ENERGY USAGE (10^6 BOE)			CHANGE (PERCENT)	
	FY 1975[a]	FY 1977	FY 1978	FY 1975-77	FY 1975-78
SHORE HEATING OIL	10.6	10.1	9.4	-4.7	-11.3
ELECTRICITY	16.2	16.8	17.2	+3.7	+6.2
NATURAL GAS	5.1	4.2	4.4	-17.6	-13.7
COAL	0.4	0.3	0.2	-25.0	-50.0
STEAM, HOT WATER, AND PROPANE	0.3	0.3	0.4	0	+33.3
TOTAL[b]	32.6	31.7	31.6	-2.8	-3.1

[a] Modified to cover 1 October through 30 September.

[b] Includes cold iron support (2.7 MBOE each in 1975 and 1977, 3.0 MBOE in 1978).

Source: NAVFAC III.

Figure A-18. SHORE FACILITY ENERGY USAGE BY ENERGY FORM

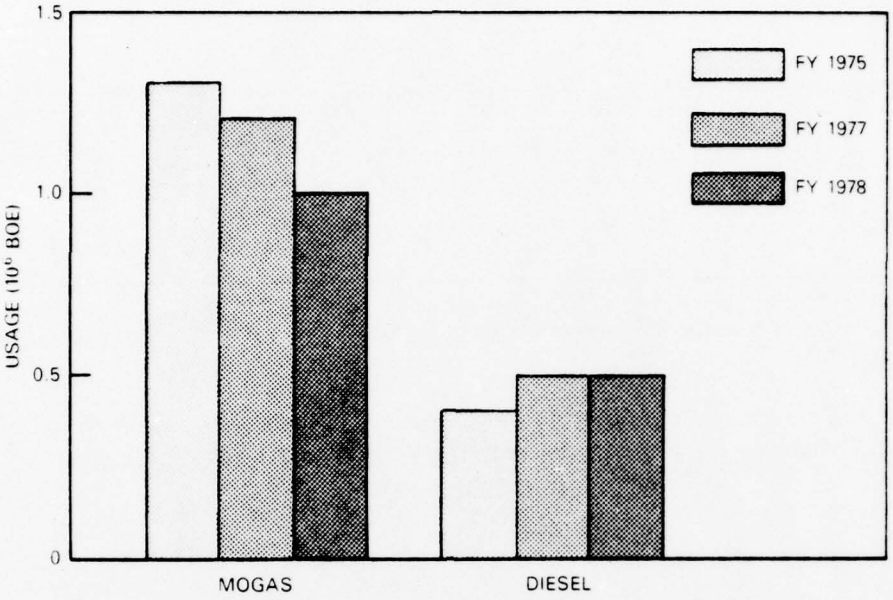
GROSS SQUARE FOOTAGE (10^6)		ENERGY USAGE (10^6 BOE)		ENERGY USAGE PER SQUARE FOOT (BOE × 10^{-3})		CHANGE (PERCENT)
FY 1975[a]	FY 1978	FY 1975[a]	FY 1978	FY 1975	FY 1978	FY 1975-78
620.6	642.4	29.9	28.6	48.2	44.5	−7.7

[a] Modified to cover 1 October through 30 September.

Note: The Navy's goal is to reduce energy use per square foot of building floor area 20 percent by 1985.

Source: OP-413.

Figure A-19. ENERGY USAGE FOR EXISTING FACILITIES EXCLUDING COLD IRON SUPPORT



FUEL TYPE	ENERGY USAGE (10^5 BOE)			CHANGE (PERCENT)	
	FY 1975[a]	FY 1977	FY 1978	FY 1975-77	FY 1975-78
MOGAS	1.3	1.2	1.0	-7.7	-23.1
DIESEL	0.4	0.5	0.5	+25.0	+25.0
TOTAL	1.7	1.7	1.5	0	-11.8

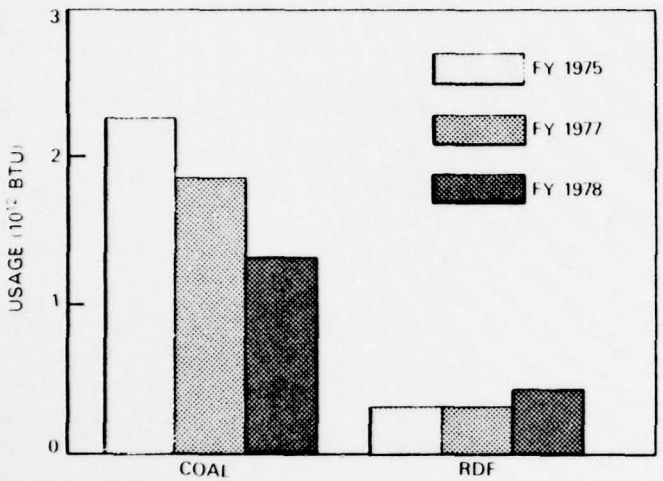
[a]Modified to cover 1 October through 30 September.

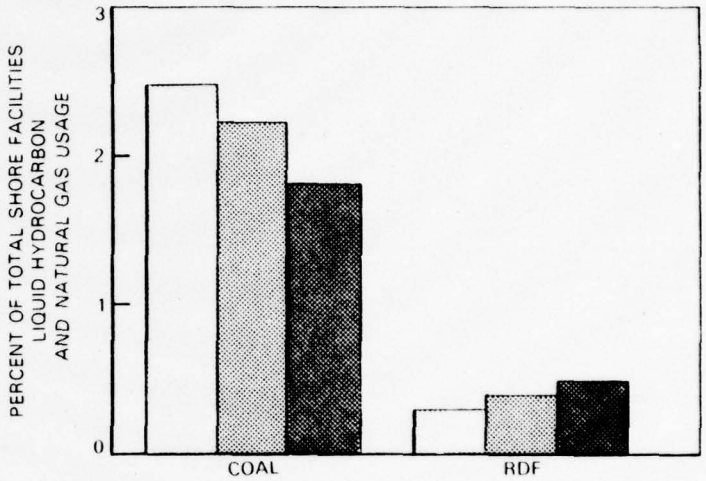
Note: The Navy's goal is to reduce energy usage 15 percent by 1985.

Source: NEUPAS

Figure A-20. VEHICLE ENERGY USAGE BY FUEL TYPE

ENERGY FORM	USAGE (10^{12} BTU)			CHANGE (PERCENT)		PERCENT OF TOTAL SHORE FACILITIES LIQUID HYDROCARBON AND NATURAL GAS USAGE			CHANGE (PERCENT)	
	FY 1975[a]	FY 1977	FY 1978	FY 1975 77	FY 1975 78	FY 1975[a]	FY 1977	FY 1978	FY 1975 77	FY 1975 78
COAL	2.3	1.9	1.4	17.4	39.1	2.5	2.3	1.8	8.0	28.0
RDF	0.3	0.3	0.4	0	+33.3	0.3	0.4	0.5	+33.3	+66.7
SOLAR										
GEOTHERMAL										
OTHER										
TOTAL	2.6	2.2	1.8	15.4	30.8	2.8	2.7	2.3	3.6	17.9





[a]Modified to cover 1 October through 30 September.

Source: NAVFAC III.

Figure A-21. ENERGY USAGE BY ALTERNATIVE FORM

APPENDIX B
FEDERAL ENERGY ORGANIZATION

APPENDIX B

FEDERAL ENERGY ORGANIZATION

DEPARTMENT OF ENERGY

Pursuant to the Department of Energy Organization Act (P.L. 95-91), President Carter activated the Department of Energy (DOE) on 1 October 1977, and named James R. Schlesinger as the first Secretary of Energy.

The creation of DOE was an important step toward dealing with the energy situation in the United States. The Department provides a framework for giving direction and focus to the nation's energy future and carrying out a comprehensive national energy plan. DOE will assist both the public and private sectors as they work together to bring domestic energy supply and demand into balance.

Energy-related personnel and functions were transferred to the new Department from the Federal Energy Administration, Federal Power Commission, Energy Research and Development Administration, Department of Interior, Department of Defense (Navy), Interstate Commerce Commission, Department of Commerce, and the Department of Housing and Urban Development. DOE continues to coordinate a number of programs with other agencies, including energy leasing policy with the Department of Interior, rural electrification with the Department of Agriculture, fuel efficiency standards with the Department of Transportation, and international energy activities with the Department of State and the Agency for International Development.

In general, the organization of DOE, shown in Figure B-1, facilitates the evolution of energy technologies through the research, development, and commercialization phases. In addition to the organizational elements shown in Figure B-1, DOE maintains an extensive field organization, including regional offices; power marketing, transmission, and production facilities; energy research centers and laboratories; and defense-related nuclear weapons laboratories and facilities.

The mission of DOE includes:

- *Energy Supply—Research and Technology Development*—oriented toward developing and improving the efficiency of existing energy technologies. Includes efforts associated with basic research, technology development, engineering development, and demonstrations.
- *Energy Supply—Production, Demonstration, and Distribution*—oriented toward developing plans and projects, and determining requirements for expanded domestic production of energy resources including coal, oil, natural gas, electricity, solar, geothermal, and nuclear. This element includes the development and implementation of programs to ensure appropriate development and utilization of energy resources and support facilities; demonstration of new technologies aimed at

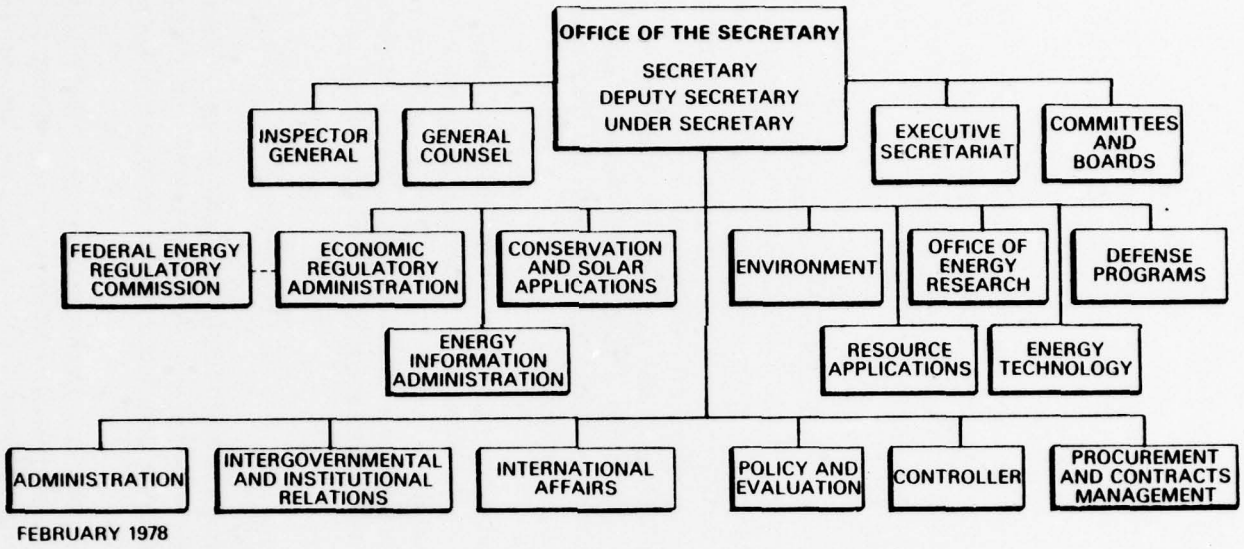


Figure B-1. DEPARTMENT OF ENERGY ORGANIZATION

stimulating adaption of the technology being demonstrated by the private sector; administration of federal energy supply reserves; uranium enrichment services; and the production and distribution of all other energy fuel forms.

- *Conservation*—directed toward reducing end-use energy consumption and increasing efficiency of energy utilization in all sectors of the national economy.
- *Regulation*—which deals with the development of regulations, allocation, and compliance responsibilities, including legal and appeals activities. The regulatory elements of DOE are the responsibility of the Federal Energy Regulatory Commission or the Economic Regulatory Administration (ERA).
- *Emergency Preparedness*—which ensures that the emergency petroleum conservation measures are in place to restrain demand consistent with the magnitude of an energy shortfall resulting from any future energy crisis, and to meet U.S. requirements under the International Energy Agreement. This element ensures also that a gasoline and diesel fuel rationing system is available for activation, that appropriate contingency measures are available for nonpetroleum energy supply problems, and that standby allocation regulations and refinery yield programs are in place. This element designs and operates an Emergency Management Information System to provide real-time information on supply availability on a national scale.
- *Energy Information*—oriented toward developing, collecting, and disseminating a broad range of energy-related information. This information includes the effects of national and international energy policies, actions, and developments on the national economy and standard of living; industry performance in the area of energy resources production and distribution; the historical, current, and projected energy situation; and the effects of energy policies on energy supply, demand, price, and other factors.
- *Environment*—oriented toward identifying and evaluating environmental impacts associated with national energy policy, assessing environmental concern resulting from energy supply and conservation activities, and establishing environmental policies related to DOE activity and initiatives.
- *Policy and Management*—which supports a wide array of policy analysis and program support requirements necessary to ensure effective DOE management. This includes development and analysis of alternative energy policy proposals and legislation; evaluation of DOE programs; central planning, analysis, and evaluation capabilities for technical program issues through development of a national plan for energy research, development, and demonstration; and decontamination and decommissioning programs for disposing surplus radioactivity-contaminated facilities and sites.

In each of 10 federal regions, the Secretary of Energy is represented by a regional representative, who coordinates activities with the Assistant Secretary of Energy for Intergovernmental and Institutional Relations. These representatives work with state governors to establish regional Energy Advisory Boards; interact with local government, business, labor, and consumer groups; report on regional effects of DOE policies and programs; and make nonregulatory decisions in regional planning, conservation, energy resource development, and energy data collection.

DOE's regional allocation and compliance program is conducted by Directors of Regional Compliance. The Administrator of ERA and the field staff of the General Counsel's office supervise the directors.

Operations offices link DOE headquarters and the field laboratories and other contractor-run field installations. These offices administer contracts and manage programs and projects assigned by DOE headquarters. Operations offices report to the Under Secretary and receive specific program direction from the Assistant Secretaries and the Director of Energy Research.

CONGRESSIONAL COMMITTEES

Since the Arab oil embargo, the Congress has played an instrumental role in formulating national energy policy and developing the governmental apparatus to respond to the energy crisis. Table B-1 shows the major Congressional committees with jurisdiction over energy and related environmental legislation and programs.

Major legislative accomplishments have included the Emergency Petroleum Allocation Act, Federal Energy Administration Act, Energy Supply and Environmental Coordination Act, Energy Policy and Conservation Act, and the Energy Conservation and Production Act.

Table B-1. CONGRESSIONAL COMMITTEES WITH JURISDICTION OVER ENERGY AND RELATED ENVIRONMENTAL PROGRAMS

Congressional Committee	Jurisdiction
Senate	
Energy and Natural Resources Committee	Energy policy, RD&D, production, distribution, and utilization; nonmilitary development of nuclear energy.
Environmental and Public Work Committee	Environmental policy R&D, resource utilization and conservation, and nonmilitary regulation and control of nuclear energy.
House	
Armed Services Committee	Conservation, development, and use of naval petroleum and oil shale reserves; military applications of nuclear energy.
Interior and Insular Affairs Committee	Domestic nuclear energy R&D and industry; geological survey mineral sources on public lands (and mining interests generally); petroleum conservation on public lands; geothermal resources for producing water and power; selected matters related to environmental impacts of laws.
Interstate and Foreign Commerce Committee	Interstate oil compacts and petroleum and natural gas (except on public lands); regulation of interstate power transmission; regulation of nuclear and nonnuclear energy facilities and use; the Clean Air Act; environmental protection in general; oversight functions with respect to laws; programs and government activities affecting nuclear energy.
Committee on Science and Technology	Energy R&D (except nuclear) and environmental R&D.

APPENDIX C
THE NATIONAL ENERGY ACT

APPENDIX C

THE NATIONAL ENERGY ACT

The National Energy Act (NEA) was signed into law by the President on 9 November 1978. The provisions of this Act apply specifically to shore facilities. The purpose of the Act is to provide for moderate, planned energy price increases that have minimal adverse effect on the nation's economy, and allow increases in prices that will motivate the users of energy to reduce their energy consumption and use energy more efficiently. The provisions of the Act are expected to reduce oil import needs by 1985 through gradual conversion of oil and natural gas usage to renewable energy sources such as coal, solar, and biomass. The NEA consists of five separate bills:

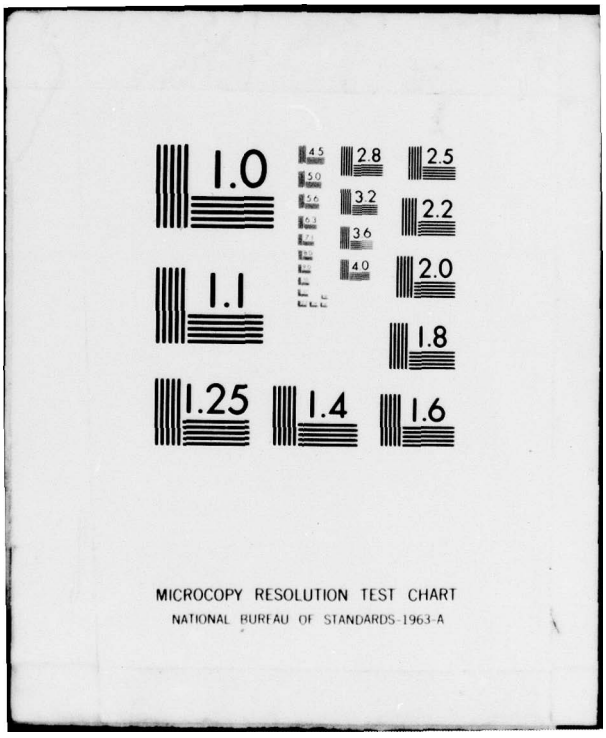
- *National Energy Conservation Policy Act of 1978,* which emphasizes energy conservation and encourages the use of solar energy whenever practical, where oil and gas are now used. It recognizes that a major component of the nation's effort to sustain economic growth and productivity over the long run depends upon initiatives for reducing the growth in energy demand as well as developing the use of renewable energy sources.
- *Power Plant and Industrial Fuel Use Act of 1978,* which emphasizes conversion of large oil and natural gas boilers to coal. It prohibits the use of oil and gas in new electric utility generating facilities or in new industrial boilers with a fuel heat input rate of at least 100 million Btu/hour.
- *Public Utilities Regulatory Policy Act of 1978,* which encourages state regulatory authorities to consider time-of-day pricing, seasonal rates, cost of service pricing, interruptible rates, and lifeline rates, and prohibits declining block rates favoring larger users by pricing successive blocks at lower per-unit prices (resulting in higher electrical and natural gas rates to the Navy). In the past, the costs of utilities have risen substantially because of marked increases in the cost of construction, capital, and fuels. The purpose of the bill is to restructure electric and natural gas rates to encourage conservation of energy, efficient use of facilities and resources, and equitable rates to electricity and natural gas consumers.
- *Natural Gas Policy Act of 1978,* which sets a series of maximum lawful price increases for various categories of natural gas. Price controls on new gas and certain intrastate gas will be lifted as of 1 January 1985. The President may declare an emergency if a gas shortage exists or is imminent and endangers supplies for "high priority" uses, such as in residences/small commercial establishments, or any use the curtailment of which would endanger life, health, or maintenance of physical property. Prices to the Navy will increase at a high rate until the price of gas equals or exceeds the price of middle distillate oil.
- *National Energy Tax Act of 1978,* which provides for various taxes, or tax credits to motivate energy users to use less energy or to substitute renewable energy for nonrenewable oil and natural gas.

The first two provisions of the NEA apply directly to naval installations and power plants

AD-A074 834 TETRA TECH INC ARLINGTON VA F/G 5/1
DEPARTMENT OF THE NAVY ENERGY PROGRAM AND PLAN - 1979.(U)
AUG 79 N00014-78-C-0097
UNCLASSIFIED TETRAT-TT-A-6065-79-405 OPNAV-41P4.A NL

3 OF 3
AD
A074834

END
DATE
FILMED
11-79
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

and are discussed in detail; the latter three affect overall energy pricing policy and are listed here only to describe all bills in the NEA.

Title V of the National Energy Conservation Policy Act of 1978 pertains specifically to federal agencies. The purpose of the Act is to reduce the growth in demand for energy and to conserve nonrenewable energy sources produced in the United States and elsewhere, without inhibiting beneficial economic growth. In Title V, the Congress reports that the United States is facing an energy shortage, particularly for oil and natural gas, and that the nation has insufficient domestic supplies of oil and natural gas to satisfy demand. According to the Congress, unless effective measures are taken by federal agencies and other users of energy to reduce the energy demand growth rate, the United States will become increasingly dependent on the world oil market and increasingly vulnerable to interruption of oil received from foreign sources.

In Part 3 of Title V of the National Energy Conservation Policy Act, the Congress states that there is an urgent need to promote the design, construction, and operation of buildings to conserve energy and make more efficient use of fuels and energy in federal buildings. In the construction or renovation of buildings, the cost of energy consumed over the life of such buildings must be considered as well as the initial cost of such construction or renovation. The Congress also states that the federal government, as the largest energy consumer in the United States, should be in the forefront in implementing energy conservation measures.

The purpose of Part 3 is to promote the use of commonly accepted methods to establish and compare the life-cycle costs of operating federal buildings and the life-cycle fuel and energy requirements of such buildings, with or without special features of energy conservation, and to promote the use of solar heating and cooling and other renewable energy sources in federal buildings. (Life-cycle cost is defined as the total costs of owning, operating, and maintaining a building over its useful life, including its fuel and energy cost.)

Authority for establishing life-cycle cost methods is assigned to the Department of Energy (DOE) in consultation with the Office of Management and Budget, the National Bureau of Standards, and the General Services Administration. DOE is required to establish practical and effective methods for estimating life-cycle costs for federal buildings, and develop and prescribe the procedures to be followed in implementing the methods developed by DOE. The law requires all new federal buildings to be life-cycle cost-effective and cost evaluations of new buildings to be made on the basis of life-cycle cost rather than on initial cost.

DOE is also required to establish, for the federal government, energy performance targets for federal buildings and to take such actions as appropriate to promote achievement of such targets in federal buildings.

Federal agencies are required to conduct a preliminary energy audit of all federal buildings under their occupancy or control, which contain 30,000 or more square feet of floor area by no later than 15 August 1979. Agencies must furnish to DOE the results of the audits, and DOE must provide to the Congress a full report on all preliminary energy audits.

As soon as possible after completing the energy audits, but no later than 15 August 1980, each federal agency is required to conduct a preliminary energy audit of all federal buildings under their occupancy or control having 1,000 to 30,000 square feet of floor area. Agencies must provide DOE with the results of the audits, and DOE must provide the Congress with a full report on all energy audits conducted under this part of the law.

Part 3 of Title V requires federal agencies to use the energy audits to select buildings for retrofit measures to improve their energy efficiency in general and to minimize their life-cycle cost. Retrofit measures will include (but are not limited to) energy conservation, solar technology and other renewable energy resources measures, and any maintenance and operating procedures determined by the energy audits as appropriate energy conservation measures. The law requires federal agencies to give priority to low or no cost changes in maintenance and building operating procedures over measures requiring substantial structural modifications and investments.

At least 1 percent of an agency's total floor area must be retrofitted during the first full fiscal year after enactment of the laws and an additional percentage at least 1 percent higher must be retrofitted during the second year, with annual increases in retrofits thereafter to assure all footage is retrofitted by 1 January 1990. In its annual budget submissions to Congress, each agency is required to specifically set forth and identify in a separate line item the funds requested for retrofit measures to be funded under this law.

Finally, Part 3 of the law requires each federal agency to provide DOE with full and complete information on its program and activities in regard to this law. DOE in turn is required to provide the Congress with a comprehensive report on all federal government activities funded under this law toward the achievement of Congress' energy objectives.

The Power Plant and Industrial Fuel Use Act places a restriction on new fuel-burning installations of 100 million Btu/hour, prohibiting the use of natural gas or petroleum as a primary energy source. The law does provide, however, for specific exemptions, which must be approved by DOE. Also, if an existing installation of 100 million Btu/hour has or previously had a technical capability to use coal or another alternate fuel as a primary energy source, the Fuel Use Act prohibits, in accordance with stated rules, the use of petroleum or natural gas, or both, as a primary energy source. This same restriction applies to installations that have the technical capability to use coal or another alternate fuel as a primary energy source, or could have such capability without substantial physical modification of the plant or substantial reduction in the rated capacity of the plant; as well as to existing installations where it is financially feasible to use coal or another alternate fuel as a primary energy source.

APPENDIX D

COOPERATIVE ENERGY TECHNOLOGY AND DEMONSTRATION PROJECTS WITH OTHER FEDERAL AGENCIES

APPENDIX D

COOPERATIVE ENERGY TECHNOLOGY AND DEMONSTRATION PROJECTS WITH OTHER FEDERAL AGENCIES

To provide operational naval forces with the equipment, procedures, and energy forms required to achieve the energy objectives and goals promulgated in OPNAV Instruction 4100.5A, the Navy depends heavily on the technology base created by both national and industrial energy programs. The major portion of this technology base is acquired through information exchange. To further assist in meeting its requirements as a major energy user, the Navy serves as cosponsor with other federal agencies in joint energy technology development and demonstration programs. Most of the cooperative agreements for these programs call for the use of the Navy operational environment for testing and demonstrating new energy technologies. Testing and demonstrating these technologies will speed commercialization in the civilian sector and allow the Navy to maintain the fuel supplies necessary to execute its role in the national defense. Table D-1 lists the various agreements included in the Navy's energy program.

When agreement is reached on the scope of a joint project, a Memorandum of Understanding (MOU) is prepared and approved by the Navy and the appropriate agency. Interaction between the Navy and a cosponsoring agency with respect to a given project may take several forms: exchange of technical information; sharing of resources, such as personnel, facilities, or equipment; and joint funding of a project. The transfer of funds or the sharing of resources is documented in a project-specific Interagency Agreement (IA).

DEPARTMENT OF ENERGY

Under a Department of Defense (DOD)/Department of Energy (DOE) agreement, the Navy has cosigned three MOUs with the major divisions of DOE responsible for conservation technology. This exchange of information and technology is expected to be useful for Navy facilities, while also providing some benefit to ships and aircraft. The areas of technical interest outlined in the conservation MOUs with the three DOE divisions are:

- Division of Fossil Fuel Utilization, Energy Technology
  - — Components and heat engines
  - — Heat utilization
  - — Fuel cells
  - — Combustion
  - — Materials and fabrication
  - — Thermodynamics and heat transfer
  - — Controls and process efficiency
- Division of Industrial Energy Conservation, Conservation and Solar Applications
  - — Industrial processes
  - — Heat recovery

Table D-1. NAVY COOPERATIVE AGREEMENTS WITH OTHER FEDERAL AGENCIES

Navy Performer/ Funding Agency	Title and Description	Agreement Number (Start – End Dates)
NRL/DOE	**Bulk Energy Storage—SOLCHEM** Develop bulk storage for solar thermal utility power.	E(49-28)-1024 (7/76 – 10/80)
NRL/DOE	**Development of a Solar Chemical Heat Receiver** Demonstrate the technical feasibility of heat receiver based in the decomposition of SO_3.	– (8/77 – 9/78)
NRL/DOE	**Improvement of the Lead Acid Battery for Load Leveling Application** Improve performance of lead-acid battery to make it a more practical and economical means of energy storage for power load leveling and peak shaving through improved manufacturing steps or changes in battery materials.	EC-77-A-31-1002 (12/75 – 9/78)
NRL/DOE	**Aging Process in Solid Dielectric Cables** Understand aging process and develop short-term aging test for cables, undestructive and less than 6 months in duration.	ET-78-I-01-2597 (4/78 – 4/82)
NWC/DOE	**Coso Drilling Testing Support Program** Support DOE-sponsored drilling operations to evaluate the geothermal potential of the Coso geothermal area of NWC. Drill a number of shallow heat Dow holes followed by deeper drilling to depths as great as 5,000 feet using a full sized drilling rig.	EG-77-A-08-1535 (12/75 – 9/79)
NWC/DOE	**Photovoltaic Power for Remote Sites** Demonstrate feasibility of supplying power for remote radar using photovoltaic power.	MERADCOM Agreement (1976 –)
NWC/DOE	***Heliostats Evaluation*** Install and test solar collector (heliostats) to be used in central tower solar thermal electric generators.	McDonnell-Douglas Corp. Letter (1975 –)
NWC/EPA	**Conversion of Trash to Gasoline** Develop a process by which municipal trash could be converted to a high-octane gasoline.	EPA-IAG-D7-0781 (11/75 –)
NWC/DOE	**Heat Exchanger Technology Appraisal and Development** Facilitate waste heat recovery and utilization.	EC-78-A-31-1064 (1/76 – 9/78)
NWC/DOE	**Conduct Experimental Release of Natural Gas (LNG)** Assess the hazards of LNG spilled on land/water.	EE-77-A-28-3248 (7/77 – 9/80)
NWSC/DOE	**Support Analysis of Energy Conserving Materials** Investigate corrosion problems with insulating materials, particularly cellulose.	– (3/76 – 9/78)
NAVFAC/DOE	**Energy Optimization Study of Sewell's Point Naval Complex** Conduct feasibility analysis of various individual and/ or combinations of actions that may lead to demonstration of energy optimization community systems and community design in existing communities.	– (10/77 – 10/78)
NAVFAC/DOE	**Fluidized-Bed Boiler Demonstration** Develop a fluidized-bed boiler at NTC, Great Lakes, Illinois, for industrial application – space heating/ cogeneration.	– (10/76 – 9/80)

Table D-1. NAVY COOPERATIVE AGREEMENTS WITH OTHER FEDERAL AGENCIES (Cont'd)

Navy Performer/ Funding Agency	Title and Description	Agreement Number (Start – End Dates)
NAVFAC/DOE	**Technical Management of OTEC Program Activity** Assist in preparation of statements of work, selection of contractors, review of proposals and evaluation of contract results in ocean engineering area.	EX-76-A-29-1000 (2/74 – 9/78)
NAVFAC/DOE	**Management Support of Offshore WECS** Assess methodology developed by Westinghouse Electric Corporation leading to a determination of the technical and economic feasibility of offshore WECS.	E(49-18)-2330 (8/76 – 9/78)
NAVSEA/DOE	**Experimental Investigation of External Heat Transfer in OTEC Heat Exchangers** Design and test apparatus for the testing of water side (external) heat transfer for OTEC appliance. The apparatus is to be operated with seawater off *Keahole Point, Hawaii.*	EG-77-A-29-1075 (3/77 – 9/78)
NAVSEA/DOE	**Design and Experimental Investigation Related to Two-Phase Flow Heat Exchanger; Mechanical Assistance** Develop low-cost heat exchangers for OTEC. Exchangers are shell-less and employ folded aluminum tubes with ammonia charging phases within the tubes.	EG-77-A-29-1076 (– 9/78)
NAVSEA/DOE	**Development of Grazing OTEC Plantship** Design, develop, fabricate, and demonstrate a a movable (grazing) OTEC plantship.	EG-77-A-29-1076 (1/76 – 9/78)
NAVSEA/DOE	**Mission Study** Provide technical assistance in definition/planning area for OTEC.	EG-77-A-29-1076 (– 9/78)
NAVSEA/DOE	**Regional Study for the Development of Hydroelectric Energy in the Eastern United States** Identify technological, environmental, societal, financial, and legal constraints which are perceived to impact on the development of low-head hydropower resources.	EG-77-A-36-1022 (8/77 – 9/78)
NAVSEA/DOE	**Support of Regional Development of Geothermal Resources in the Midwestern, Central, and Eastern United States** Assess the potential of geothermal resources in the eastern region for direct heat application and generate scenarios for their development and utilization.	EX-76-A-36-1008 (4/76 – 12/78)
NAVSEA/DOE	**Aerospace Nuclear Safety Programs** Evaluate reentry aspects of space nuclear power.	– (1971 – 9/78)
ONR/DOE	**Advisory Center on Toxicology** Provide support.	EX-76-A-28-1283 (1956 – 6/78)
CEL/EPA	**Investigation of Refuse Size Reduction Alternatives** Improve health, safety, and cost-effectiveness of solid waste handling through conversion of raw refuse to high-density extrusions at the generating site.	
CEL/DOE	**Hospital Design and Retrofit Demonstration** Study energy conservation in hospitals with regard to ventilation requirements, air stream heat recovery, kitchens and laundries, and lighting standards and control.	– (1/77 – 9/80)

Table D-1. NAVY COOPERATIVE AGREEMENTS WITH OTHER FEDERAL AGENCIES (Cont'd)

Navy Performer/ Funding Agency	Title and Description	Agreement Number (Start – End Dates)
CEL/DOE	**Antifouling Marine Concrete** Develop a long-lasting structurally strong and environmentally safe antifouling marine concrete for use in OTEC platform.	EC-77-A-29-1104 (7/76 – 9/78)
NAVMAT/DOE	**Cooperative Agreement with the Division of Power Systems** Identify specific areas of technical interest and provide guidelines for cooperative actions. Areas of information and/or resource exchange include components and heat engines, heat utilization, fuel cells, combustion, materials and fabrication, thermodynamics and heat transfer, and controls and process efficiency.	
NAVMAT/DOE	**Cooperative Agreement with the Division Conservation and** Identify specific areas of technical interest and provide guidelines for cooperative actions. Areas of information and/or resource exchange include energy data gathering and analysis techniques, infiltration, ventilation, heat energy, service water, illumination, heat pumps, energy monitoring and control systems, thermal mass utilization, innovative energy-saving technologies and methodologies, and construction methods and materials.	
NAVMAT/DOE	**Cooperative Agreement with the Division of Industrial Energy Conservation** Identify specific areas of technical interest and provide guidelines for cooperative actions. Areas of information and/or resource exchange include industrial processes, heat recovery, heat pump technologies, cogeneration, technology transfer, surveys, and innovative energy-saving technologies.	
NAVMAT/DOE	**Shale Oil Production, Refining and End-Use Testing** Provide for the mining, retorting, storage, transportation, refining, testing, and evaluation of synthetic fuels from oil shale obtained from Naval Oil Shale Reserves 1 and 3, and other sources.	EF-77-A-01-2730 (4/76 – 9/78)
NAVMAT/EPA	**Shale Oil Production, Refining and End-Use Testing** Determine the environmental acceptability of current petroleum refining practices with respect to shale oil and the need for applicable control technology use or development.	
NAVMAT, NAVFAC, CEL/DOE	**Organic Rankine Bottoming Cycle** Demonstrate feasibility under a military environment.	– (1977 – 1983)
NAVSEC/DOE	**Electric Vehicle Batteries and Nickel-Zinc Battery Research** Provide research, development, and technical support for electric vehicle battery program and for nickel-zinc batteries.	EC-77-A-31-1063 (9/77 – 9/78)
NSWC/DOE	**Nitinal Materials as Elements of Energy Conversion Systems** Establish an interagency program to further the development of nitinol as a solid-state heat engine element.	– (6/78 – 6/79)

Table D-1. NAVY COOPERATIVE AGREEMENTS WITH OTHER FEDERAL AGENCIES (Cont'd)

Navy Performer/ Funding Agency	Title and Description	Agreement Number (Start—End Dates)
DTNSRDC/DOE	**Experimental Program to Investigate Countermeasures to Microbiofouling of OTEC Heat Exchanger Surfaces** Obtain optimum countermeasures for OTEC heat exchangers using biofouling and cleaning studies.	EG-77-A-29-1109 (9/77—9/78)
NORDA/DOE	**Elastomer Cold Pipe Systems for the OTEC Modular Experimental Platforms** Evaluate and report on conceptual designs proposed by elastomer industry for 30-foot diameter cold water pipe required for the 20 MW modular experiment platforms.	— (—9/78)

- — Heat pump technologies
- — Cogeneration
- — Technology transfer
- — Surveys
- — Innovative energy-sharing technologies

- Division of Buildings and Community Systems, Conservation and Solar Applications
  - — Energy data gathering and analysis techniques
  - — Infiltration
  - — Ventilation
  - — Energy monitoring and control systems
  - — Heat recovery
  - — Service water
  - — Illumination
  - — Heat pumps
  - — Energy used in building processes
  - — Standard testing of building components/systems
  - — Thermal mass utilization
  - — Innovative shelter design
  - — Innovative shelter energy-saving technologies
  - — Innovative energy-saving methodologies
  - — Construction methods and materials

As part of the national energy program, efforts are being directed toward establishing the technology required for the commercial development of synthetic liquid hydrocarbon fuels derived from domestic sources of coal, oil shale, and tar sands. In cooperation with DOE, DOD is encouraging the production of synthetic fuels for military use. By assessing the suitability of synthetic fuels for service use, DOD will become an informed customer for the products of the developing synthetic fuels industry.

An IA (EF-77-A-01-2730) was negotiated between Naval Material Command and the Energy Research and Development Administration (now DOE) to conduct a program entitled "Shale Oil Production, Refining, and End-Use Testing." The principal program objectives of this IA are to:

- Produce full-specification military fuels in sufficient quantities for significant operational testing.
- Produce such fuels under commercial refinery conditions.
- Accumulate data on the extraction technology, processing requirements, yield, economics, and other parameters that affect the utilization of domestic crude shale oil as a feedstock for military fuels.
- Determine the operational and hardware compatibility of shale-derived fuels in military systems.
- Determine the extent to which current fuels and system specifications should be modified to best utilize fuels derived from crude shale feedstocks.

The initial project under this IA utilizes crude shale oil produced from the Naval Oil Shale Reserves, using the Paraho retorting technology. Additional refining and end-use testing projects will utilize crude shale oils produced by other retorting technologies.

The Navy, in an IA signed in October 1976, is participating with DOE in demonstrating the feasibility of a fluidized-bed boiler central coal heating plant. This demonstration is being conducted at the Naval base at Great Lakes, Illinois.

Naval Weapons Center (NWC), China Lake, California, has signed a cooperative agreement to support DOE's effort to assess the Coso geothermal resource at China Lake (EG-77-A-08-1535).

Naval Research Laboratory is providing R&D support for DOE in bulk storage (E(49-28)-1024) and battery storage (EC-77-A-31-1002).

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The Navy is monitoring the National Aeronautics and Space Administration funded Aircraft Energy Efficiency (ACEE) program initiated in FY 1976, as well as other aircraft technology programs. Many technical aspects of the ACEE program are valuable to the Navy's planning for an advanced patrol aircraft, particularly:

- Engine and engine component development.
- Composite aircraft structures.
- Advanced aerodynamics design.
- Energy-efficient transport design.
- Advanced turbo prop systems.

DEPARTMENT OF COMMERCE, MARITIME ADMINISTRATION

The Navy maintains an active information exchange program in ship energy conservation with the Maritime Administration (MARAD), particularly in the areas of prime movers

and propulsors. Although the current level of interaction is information exchange, joint tests of MARAD-deployed systems are envisioned.

ARMY MOBILITY EQUIPMENT RESEARCH AND DEVELOPMENT COMMAND

NWC provides support to the photovoltaic utilization program administered by the Mobility Equipment R&D Command (MERADCOM) for DOE.

ENVIRONMENTAL PROTECTION AGENCY

With Environmental Protection Agency (EPA) funding, NWC developed a process to convert municipal waste to high-octane gasoline. This work is being continued under EPA-IAG-D-7-0781.

APPENDIX E
OPNAV INSTRUCTION 4100.5A

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D.C. 20350

IN REPLY REFER TO
Ser 00/500242
OPNAVINST 4100.5A
Op-413
9 May 1978

OPNAV INSTRUCTION 4100.5A

From: Chief of Naval Operations

Subj: Energy Resource Management

Ref: (a) Navy Energy Plan of 26 Jan 77
(b) Executive Order 12003 of 20 Jul 77 (NOTAL)
(c) NAVSUPINST 4600.70, Military Traffic Management Regulation
(d) OPNAVINST 4100.6
(e) DOD-ERDA Memorandum of Understanding of 15 Jan 77

1. Purpose. This instruction provides policy, goals, objectives, and assigns responsibilities for the management of energy resources for ships, aircraft, vehicles and shore installations.

2. Cancellation. OPNAVINST 4100.5.

3. Background. Many of the Navy's current and projected military systems use petroleum fuels. These fuels are projected to be in short supply within the expected life cycle of the systems they support. This source of energy is also subject to interdiction and to capricious economic actions by foreign nations. The diminishing sources of petroleum and escalating prices could impact seriously on the ability of the Navy to fulfill its primary mission responsibilities.

a. Energy conservation efforts through FY1977 have realized a 27% reduction in consumption since FY1973. However, 60% of these savings have resulted from reduced ship and aircraft strengths and reduced operating tempos. Further reduction of this type would degrade operational readiness to an unacceptable degree. Accordingly, future energy savings must be obtained through improvements in energy conversion efficiencies, use of energy efficient procedures and reduction of energy waste. Fuel saved through more efficient operations can be utilized to increase levels of operating tempos and thereby improve readiness.

b. In addition to conservation, energy resource management requires rational use of critical materials, and substitution of more abundant energy forms such as coal,

solar, geothermal, refuse, waste oil (contaminated fuel oil and used lube oil), and synthetic fuels for petroleum and natural gas.

c. The Navy's energy organization, energy programs, historical consumption data and initiatives to be undertaken to reduce energy consumption are described in reference (a).

4. Policy. Every effort shall be made to achieve the objectives and goals of this instruction without compromise to military readiness, safety, and effectiveness. Waivers from this requirement due to operational commitment should be sought directly from the Chief of Naval Operations via the appropriate administrative chain of command. Except for specific projects the resources required to execute this direction are considered to be within assets currently available or programmed.

5. Objectives. The objectives of energy resource management within the Navy are to:

a. Achieve maximum practical energy conservation for facilities and operations with particular emphasis on conservation of petroleum and natural gas.

b. Substitute, when economically practical, alternative, more abundant or renewable energy sources where petroleum and natural gas are now used.

c. Consider the effect of energy policy and actions on the health, welfare, and safety of Navy personnel and the environment.

6. Goals. The Navy Energy Resource management goals are in support of the federal energy program outlined in reference (b) and DOD energy programs. Accomplishment of the goals will be measured at the activity level except where noted. Every effort shall be made to achieve these goals by 1985. Goals are measured from the 1975 baseline (1 October 1974 to 30 September 1975):

a. Existing Facilities: 20 percent energy use reduction per gross square foot of building floor area.

b. New Facilities: 45 percent energy use reduction per gross square foot to be achieved in all new construction design specifications measured relative to FY 1975 designed average energy consumption per gross square foot. (Approved projects underway on effective date of this instruction will be accommodated through the retrofit program).

c. Ground support equipment energy savings of 15 percent.

d. 20 percent reduction in fossil fuel energy consumption per ship underway steaming hour.

e. 90 percent reduction in fleet and shore fuel surveys.

f. 5 percent reduction in fossil fuel energy consumption per flight hour.

g. 9 percent energy savings per year by 1985 through simulator substitution. (Measure at overall Navy level)

h. Substitution of more abundant or renewable energy forms for petroleum or natural gas used ashore, culminating in a total substitution of 5 percent. (Measure at overall Navy level)

7. Action. The following specific actions will be taken by responsible commanders:

a. Office of the Chief of Naval Operations

(1) The Deputy Chief of Naval Operations (Logistics) or his designee shall:

(a) Have responsibility for establishing policy, directing, coordinating, and monitoring the energy program within the Navy.

(b) Include energy resource requirements in the POM.

(c) Establish requirements for development of new methods and technology relating to energy conservation and alternate energy sources.

(d) Assure effective coordination with the Department of Defense and other government agencies involved in energy resource management.

(2) The Director, Research, Development, Test and Evaluation shall implement the CNO's responsibilities with respect to planning, programming and appraising the Energy R&D program. He recommends funding profiles which give proper weight to energy R&D requirements within the context of the total Navy R&D budget.

(3) Deputy Chiefs (DCNO's) and Directors of Major Staff Offices (DMSO's) of Naval Operations shall:

(a) As Program Sponsors, make provisions in their respective plans, programs, and budgets for improving management of energy resources consistent with the provisions of this instruction.

(b) Incorporate an energy effectiveness review into the system acquisition and planning process. All Navy systems in the program initiation, demonstration and validation, full-scale engineering development, and production and deployment phases will be subject to this review. The objective is to integrate energy consumption data as an element of operating and support cost in the Life Cycle Cost (LCC) and Design to Cost goals. These energy effectiveness reviews will include major systems, components, and subsystems within the acquisition process.

(4) The Chief of Information (CHINFO) shall coordinate and supervise the release of information concerning energy resource matters to internal and external publics through appropriate media.

b. Major Claimants shall:

(1) Establish energy resource management plans to achieve the objectives and goals of this instruction, and to comply with the shore, vehicle, ship and aircraft energy standards as promulgated by the Chief of Naval Material. Insure subordinate commands and activities initiate similar plans.

(2) Assign line responsibility for energy resource management. The assignment will be a primary or major collateral duty.

(3) Identify, submit, and implement projects for the most effective conservation actions.

(4) Include in contract pre-award surveys and negotiated procurement evaluation factors the consideration of energy consumption, and availability of alternate energy sources.

(5) Use the least fuel-consumptive carriers and modes of transportation in accordance with reference (c).

(6) Discontinue the disposal of waste oils as road cover and minimize where possible the sale of waste oils to commercial vendors.

(7) Maximize availability of shore power and steam for utilization by ships in port. Include projected requirements in "MILCON" requests.

c. Chief of Naval Material shall:

(1) Provide the necessary criteria, operations and maintenance standards, management guidance and engineering expertise necessary to identify and implement those shore facilities conservation actions which will best assist the Major Claimants in meeting the objectives and goals of this instruction.

(2) Develop and provide design criteria necessary to achieve 45% energy use reduction goal for new buildings outlined in paragraph 6b.

(3) Promulgate procedures for the collection, reprocessing, recycling, blending, and burning of waste oils in land based Navy combustion equipment.

(4) Analyze and recommend where economical and practical the use of alternative, renewable energy sources or more abundant non-renewable energy sources, when constructing new facilities/systems or replacing existing facilities/systems. At a minimum compliance with reference (d) is required.

(5) Maintain and validate energy consumption data, flying hour data, and steaming hour data, as part of the Navy Energy Usage Profile and Analysis System (NEUPAS).

(6) Review all proposed agreements on energy R&D matters between Navy activities and organizations outside the Navy to ensure conformity with Navy mission requirements, policy, and objectives. Final approval authority and coordination responsibility for all such agreements will reside with the Chief of Naval Material. Ensure that all such agreements with Department of Energy (DOE) conform with the terms of reference (e).

(7) Develop Contract procedures for consideration by the Armed Service Procurement Regulations (ASPR) committee

directed at minimizing procurement interruptions in time of energy shortage.

(8) Conduct R&D to develop new methods and technology relating to energy conservation and alternate energy sources.

(9) Act as the Defense Energy Information System (DEIS) administrator, responsible for liaison with Defense Logistics Agency (DLA) and Major Claimants to insure that energy consumption reporting is timely and accurate.

d. Inspectors General shall, during command inspections:

(1) Review the effectiveness of the organization established by the Command to review and control Command energy conservation actions and programs.

(2) Review the Command's implementation of conservation recommendations made by the Engineering Field Divisions (EFDs) during their Energy Conservation Surveys.

(3) Review the Command's monitoring for accuracy of DEIS data and verifying that their activities are reporting only approved baselines.

J. L. HOLLOWAY III
Admiral, U. S. Navy
Chief of Naval Operations

Distribution:
SNDL A2A (Independent Office) (Comptroller of the Navy, OCP, and Chief of Information, only)
A4A (Chief of Naval Material)
A5 (Bureaus)
21A (Fleet Commander in Chief)
22 (Fleet Commanders)
24 (Type Commanders)
41A (Commander, Military Sealift Command)
FD1 (Oceanographer of the Navy)
FE1 (Commander, Naval Security Group)
FG1 (Commander, Naval Telecommunications Command)
FKA1 (Systems Command Headquarters)
FKM12 (Navy Petroleum Office)

Distribution (continued):
FR1 (Chief of Naval Reserve)
FS1 (Commander, Naval Intelligence Command)
FT1 (Chief of Naval Education and Training)
Op's 00, 09, 090, 09BF, 02, 03, 04, 44, 05, 51, 92, and 943

Copy to:
SNDL A6 (Commandant of the Marine Corps)

Stocked:
CO, NAVPUBFORMCEN
5801 Tabor Ave.
Phila., PA 19120

APPENDIX F
MARINE CORPS ORDER 4100.4A

DEPARTMENT OF THE NAVY
HEADQUARTERS UNITED STATES MARINE CORPS
WASHINGTON, D. C 20380

MCO 4100.4A
LFF-2-ncs
27 Apr 1979

MARINE CORPS ORDER 4100.4A

From: Commandant of the Marine Corps
To: Distribution List

Subj: Energy Conservation Program

Ref: (a) Exec. Order No. 12003 (NOTAL)
(b) MCO P11000.9A (NOTAL)
(c) MCO 4100.9
(d) MCO 10340.19 (NOTAL)
(e) MCO 11370.1A (NOTAL)
(f) 15 U.S.C. 2002 (NOTAL)

Encl: (1) Format and Content of the Fleet Marine Force (FMF) Energy Conservation Report
(2) Baseline Computation Information

Reports Required: I. Energy Conservation Report (Report Symbol MC* 10340-08), par. 8a and encl. (1)
II. Baseline Computation Report (Report Symbol MC-10340-OT), par. 8b and encl. (2)

1. Purpose. To establish policy and provide guidance for the implementation of the Marine Corps Energy Conservation Program which is applicable to Marine Corps operating forces and installations.

2. Cancellation. MCO 4100.4.

3. Summary of Revision. This revision contains a substantial number of changes and should be completely reviewed.

4. Policy. It is the policy of the Marine Corps to support and implement the energy conservation goals and policies directed by higher authority. Energy costs have continued to rise and are expected to continue to do so significantly in the future. Since Marine Corps operations and training are for the present and foreseeable future, inextricably linked to the availability and use of liquid hydrocarbon fuels in an atmosphere of ever-decreasing availability and increasing cost, an active, aggressive, and dedicated Marine Corps Energy Conservation Program is essential to ensure a force in readiness. Significant reductions through conservation measures can be made without impinging on operational readiness or the health and welfare of our Marines and their families merely by ensuring that the maximum efficient use is made of all energy resources by all personnel. Leadership, command interest, initiative, example, supervision, and discipline are the key words in attainment of the goals of the Marine Corps Energy Conservation Program.

5. Objective. Through concentrated emphasis on the development and institutionalization of more efficient methods of energy utilization, it is expected that all installations and organizations will meet and exceed the

conservation goals as established by higher authority and directed by Headquarters Marine Corps. To this end, the following general objectives are established:

a. Achieve maximum practical energy conservation for facilities, operations, and training, with particular emphasis on conservation of petroleum and natural gas.

b. Substitute, when economically practical, alternative, more abundant or renewable energy sources where petroleum and natural gas are now used.

c. Consider the effect of energy policy and actions on the health, welfare, and safety of Marines and the environment.

6. Goals. Marine Corps energy conservation goals in support of reference (a) will be measured at the activity level, except where noted. Goal accomplishment will be measured against the FY 1975 adjusted baseline (1 October to 30 September 1975). The 1975 utility baseline will be corrected to mega British thermal unit (MBtu) per thousand square feet, thus precluding the need to change the baseline for each addition or deletion of facilities. Goals are established as follows:

a. Existing facilities--20-percent energy use reduction per gross square foot of building floor area by the end of FY 1985.

b. New facilities--45-percent energy use reduction per gross square foot to be achieved in all new construction design specifications measured relative to FY 1975 designed average energy consumption per gross square foot by the end of FY 1985.

c. Effect a 15-percent savings of all fuels, except those related to aviation and utility applications.

d. Effect a 90-percent savings in fuel surveyed. This applies to any fuel previously disposed of rather than utilized for a secondary or tertiary purpose. Savings may qualify only if properly reported.

e. Five-percent reduction in fossil fuel energy consumption per flight hour.

f. Nine-percent energy savings per year by the end of FY 1985 through simulator substitution (Marine Corps-wide).

g. Substitution of more abundant or renewable energy forms for petroleum or natural gas used, culminating in a total substitution of 10 percent (Marine Corps-wide).

h. Obtain 1 percent of Department of Defense (DOD) installation energy by solar and geothermal means by the end of FY 1985 (DOD-wide).

i. To have on hand at the beginning of each heating season a 30-day fuel supply for all oil only, oil-natural gas, and oil-coal heating units over 5 MBtu per hour output and to maintain this supply level throughout the 3 coldest months of the year.

7. Action

a. Major Marine Corps installations and operating forces (divisions, wings, force service support groups, etc.) shall establish an energy conservation task group at the headquarters level to act in an advisory capacity, with direct access to the commander. All levels of the command, down to battalion/squadron or comparable level, should be represented. The Marine Corps Reserve will

establish task groups at Headquarters, 4th Marine Division and 4th Marine Aircraft Wing. The energy conservation task group shall be formed of members on an additional duty basis. For installations, the existing utilities conservation and appraisal board, established in accordance with reference (b), paragraph 3003, shall satisfy the task group requirement.

b. Energy conservation shall be included as a specific item to be examined during local command inspections. Local energy conservation programs and policies will come under the scrutiny of the Inspector General of the Marine Corps during the inspection of each command.

c. Activity commanders shall take appropriate action to conserve utilities in accordance with the guidelines contained throughout reference (b) and especially in table 3-1 thereof.

d. Energy consumption shall be considered as a factor in future design, development, and construction of new facilities and equipment. (See reference (b), paragraph 3008, regarding energy consumption of new buildings.) Marine Corps activities shall work closely with the engineering field divisions of the Naval Facilities Engineering Command (NAVFACENGCOM) to ensure that new facilities meet the energy conservation goals set forth in paragraph 6b, preceding.

e. All installations shall institute energy consumption control measures, to include assignment of goals established in paragraph 6, preceding, and the reporting of actual consumption. These measures shall be alined with the Defense Energy Information Systems (DEIS) I and II reports, which provide inventory and consumption fuel data and utility consumption data to the DOD. (See reference (c).)

f. Because the disruption of bulk petroleum deliveries continues as a real threat, Marine Corps activities must continually be aware of the provisions of reference (d) concerning fuel allocation priorities in the event petroleum deliveries are curtailed. In addition, reference (e) provides information on utility fuels availability in times of crisis.

g. Contingency plans for dealing with potential energy shortages shall be developed at the installation level.

h. The following conservation policies are the basis for a "conservation ethic" promoted throughout the DOD and directed herein for continued application:

(1) Weapons, equipment, and flight demonstrations shall be the minimum considered essential for training and recruiting.

(2) Compact/subcompact commercial sedans and station wagons shall continue to be purchased for Marine Corps fleet replacement.

(3) All units shall encourage energy savings suggestions through incentive awards, to include the selection of applicants for beneficial suggestion awards, letters of commendation and appreciation, meritorious masts, etc.

(4) Carpooling shall be encouraged with the assignment of preferred parking to carpools.

(5) The exchange of ideas and knowledge on energy conservation by including this subject in troop training and information programs shall be encouraged.

(6) Large-scale energy intensive exercises shall be kept at a level required to maintain operational readiness. Exercise sponsors shall include energy requirements and conservation potential for the alternatives available in any environment impact assessment/statement prepared for the exercise.

(7) A maximum speed limit of 55 miles per hour shall be maintained for all Government vehicles as long as safety and mission considerations permit.

(8) Heating temperatures shall be maintained at 65° to 68° Fahrenheit (F) in living/working areas (exclusive of warehouses where temperatures shall be lower). Fifty-five degrees shall be maintained in working areas during non-working hours. Cooling temperatures shall be set at 78° to 80° F.

(9) The minimum statutory requirement of reference (f) shall be met for fleet average fuel economy in the Defense passenger automobile fleet by 3 miles per gallon for FY 1979 and 4 miles per gallon for FY 1980 and beyond.

(10) When applicable, specific mention shall be made in officer and enlisted fitness reports when significant energy conservation measures are achieved (either in whole or in part) by the individual reported on.

(11) Marine Corps-owned/-leased/-rented commercial vehicles shall be pooled, wherever possible.

(12) Energy consumed for lighting shall be reduced by the inactivation of nonessential lamps and fixtures and by applying nonuniform lighting standards to existing systems.

(13) Light meter surveys of working areas shall be conducted. As a general rule, during working hours, artificial lighting should be adjusted to no more than 50 footcandles at work stations, 30 footcandles in work areas, and 10 footcandles in nonworking areas. This is not intended to restrict lighting required for safety and security.

(14) Eliminate humidity control for general office spaces. Requirements for humidity control in special types of spaces or locations shall be handled on a case-by-case basis.

(15) Prohibit the operation of portable electric heater blowers, portable electric space heaters (except in those cases where this is the only source of heat available), and electric threshold heaters in Government-owned or -leased spaces.

8. Reports

a. Enclosure (1) is the format for the quarterly FMF Energy Conservation Report (Report Symbol MC* 10340-08) required by the Commandant of the Marine Corps Corps (Code LFF). The report shall be submitted by Headquarters, Fleet Marine Forces (FMF's), Pacific and Atlantic, for FMF commands and organizations. The report shall be submitted no later than the 20th day of the month following the quarter.

b. The DEIS II report provides for installations data similar to the energy conservation reports for the FMF. The 1975 baseline must be modified (updated) in order to provide an accurate basis of measurement based on the new requirement of consumption per square foot.

c. Enclosure (2) establishes the background and procedures to update the 1975 baseline in terms of MBtu per thousand square feet. This report is a one-time report and is to be submitted to the Commandant of the Marine Corps (Code LFF) by 31 May 1979. (Report Symbol MC-10340-OT has been assigned to this report.)

9. Reserve Applicability. This Order is applicable to the Marine Corps Reserve.

H. A. Hatch

H. A. HATCH
Deputy Chief of Staff
for Installations and Logistics

DISTRIBUTION: A

Copy to: 8145001

FORMAT AND CONTENT OF THE FLEET MARINE FORCE (FMF)
ENERGY CONSERVATION REPORT

Report Symbol: MC* 10340-08

1. Each quarter, the FMF Energy Conservation Report will provide FMF fuel consumption data, budget information, and a conservation program statement.

2. This information shall be submitted by Headquarters, FMF's, Pacific and Atlantic, for their respective FMF commands and organizations.

3. The following information shall be provided:

a. Unit (division, wing, force service support group, etc.).

b. Fuel, supplier, consumption (quarter), and budget information. (See paragraph 4, following.)

c. Remarks--a succinct statement of programs and actions taken, planned, or under development to effect energy conservation (reduce consumption).

4. The information requested by paragraph 3b, preceding, is defined as follows:

a. Fuel. Report aviation fuels (AVGAS, JP-4, and JP-5), and report ground equipment fuels (MOGAS and distillates). Report fuels used for other than engine operation (heat, etc.).

b. Supplier. Indicate the base or station providing the fuel (e.g., Marine Corps Base, Camp Lejeune; Marine Corps Air Station, Cherry Point; etc.).

c. Consumption. Indicate the fuel consumed for the quarter (all fuel data shall be reported in barrels (42 gallons)).

d. Budget. Indicate the amount budgeted for in barrels (per quarter).

e. Example Text. Second Marine Division:

Fuel	Supplier	Consumption	Budget
MOGAS	MCB, CLNC	2,100	2,100
Remarks:	(Program Statement)		

BASELINE COMPUTATION INFORMATION

Report Symbol: MC-10340-OT

1. Purpose. To provide procedures to measure performance against the building energy conservation goals established in Executive Order 12003.

2. Discussion

a. Executive Order 12003 requires Federal agencies to achieve a 20-percent reduction in the average energy use per gross square foot of floor area in 1985 from the average energy use per gross square foot of floor area in 1975. Executive Order 12003 also requires a reduction of 45 percent in new building energy use per gross square foot of floor area in 1985 from the average annual energy use per gross square foot of floor area in 1975.

b. The 1975 consumption will be actual consumption for the period 1 October 1974 to 30 September 1975 as reported on DEIS-II reports. The only exception allowed is for correction of errors.

c. The 1985 consumption will be measured as FY 1985 consumption to be reported on DEIS II.

d. All activities reporting on DEIS II (see the current edition of MCO 4100.9) shall determine and report a one-time baseline. See paragraph 3, following, an example of baseline computation. No baseline changes will be allowed without approval of the Commandant of the Marine Corps (Code LFF-2). All previous baselines are void.

f. Conversion factor for megawatt hours (MWH) to MBtu is 11.6; i.e., 1 MWH = 11.6 MBtu.

g. New buildings (i.e., those requiring a 45-percent energy reduction) are those buildings designed after 8 November 1979. The Commandant of the Marine Corps (Code LFF-2) will monitor new construction and apply a weighted goal as shown in the example in paragraph 4, following, to activities having new construction.

3. Fiscal Year 1975 Baseline Computation Example

Activity	Total Gross ft^2 of Buildings	Total Facilities Energy Usage (MBtu)	Baseline MBtu per ft^2
MCB Anywhere	9,171,000 ft^2 used during FY 1975	Elec: 100,820 MWH [1/] X 11.6 MBtu/MWH = 1,169,512 MBtu	
		Propane: 154,045 MBtu [1/]	$\frac{2,173,894 \text{ MBtu}}{9,171,000 \text{ ft}^2}$
		Fuel Oil: 850,337 MBtu [1/]	= 0.2370 MBtu per ft^2
		Natural Gas, Coal, Purchased Steam and Hot Water, as applicable:	
		TOTAL = 1,169,512 + 154,045 + 850,337	
		= 2,173,894 MBtu	

4. Example of Performance Evaluation by Commandant of the Marine Corps to an Activity Having New Construction

Activity: MCB, anywhere

FY 1975 baseline: 0.2370 MBtu/ft^2

Area of new buildings added since 1 October 1979: 201,280 ft^2

Area of existing buildings demolished: 0 ft^2

Area of existing buildings in FY 1975: 9,171,000 ft^2

FY 1980 energy consumption: 1,808,000 MBtu

Area of buildings added between FY 1975 and 8 November 1979: 57,060 ft^2

Current MBtu/ft^2 computation:

(Current FY energy consumption in MBtu, from DEIS II) ÷ (FY 1975 total gross ft^2 of buildings ± changes which have occurred.)

$$\frac{1{,}808{,}000 \text{ MBtu}}{(9{,}171{,}000 + 57{,}060 + 201{,}280 - 0) \text{ ft}^2} = \frac{1{,}808{,}000 \text{ MBtu}}{9{,}429{,}340 \text{ ft}^2} = .1917 \text{ MBtu/ft}^2$$

Current MBtu/ft^2 goal computation:

(FY 1975 gross ft^2 plus change in gross ft^2 between FY 1975 and 8 November 1979) (FY 1975 baseline, in MBtu/ft^2) (0.80) (change in gross ft^2 between 8 November 1979 to present) (FY 1975 baseline, in MBtu/ft^2) (0.65) ÷ (current gross ft^2)

$$\frac{(9{,}171{,}000 + 57{,}060 \text{ ft}^2)\ (.2370 \text{ MBtu/ft}^2)\ (.80) + (201{,}280 \text{ ft}^2)\ (.2370 \text{ MBtu/ft}^2)\ (.65)}{(9{,}171{,}000 + 57{,}060 + 201{,}280)} = 0.1888 \text{ MBtu/ft}^2$$

$$\% \text{ above goal} = \frac{(0.1917 - 0.1888)\ (100)}{0.1888} = 1.54\%$$

1/ Energy consumption from DEIS II reports (October 1974 through September 1975).